

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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THE REGENERATION OF THE MENINGES.....	129
WILLIAM Y. SAYAD, M.D. AND SAMUEL C. HARVEY, M.D. NEW HAVEN, CONN.	
CHRONIC EMPYEMA	142
CARL EGGER, M.D. NEW YORK	
INGUINAL HERNIA IN THE MALE.....	171
SEWARD ERDMAN, M.D. NEW YORK	
IMPROVED TECHNIC FOR GASTRECTOMY AND GASTRO-ENTEROSTOMY	190
LEONARD FREEMAN, M.D. DENVER, COLO.	
OCHSNER TREATMENT IN PERITONITIS.....	194
JOHN H. JOFSON, M.D. AND DAMON B. PFEIFFER, M.D. PHILADELPHIA	
SPONTANEOUS INTRAPERITONEAL RUPTURE OF THE BLADDER	206
JOSEPH F. GEISINGER, M.D. RICHMOND, VA.	
THE MECHANISM OF THE FORMATION OF URINARY CALCULI.....	210
LINWOOD D. KEYSER, M.D. ROCHESTER, MINN.	
SKIN GRAFTING BY EXACT PATTERN.....	223
BEVERLY DOUGLAS, M.D. NEW HAVEN, CONN.	
TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY	228
STATED MEETING HELD OCTOBER 25, 1922	
TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY.....	241
STATED MEETING HELD NOVEMBER 6 1922	
CORRESPONDENCE: Rixford; Spiral Fractures. Cole and Sutton; Hyperthyroidism with Associated Diabetes Mellitus. O'Connor; Gastro-jejunostomy for Perforated Gastric and Duodenal Ulcers.....	254

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No. 2

THE REGENERATION OF THE MENINGES *

THE DURA MATER

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It has been a general assumption that it is necessary to fill a defect in the dura mater with something resembling the normal membrane which might serve as a substitute for the absent dura. There are many references in the literature to such substitutions and many artificial membranes have been proposed.

Abbe,¹ in 1895, referred to a patient of Beach's in whom gold foil had been employed to cover the raw area left after the separation of subdural adhesions. He himself in two similar cases had employed rubber tissue. Such attempts were, however, sporadic up to the recent war, at which time this subject became of considerable interest because of the large number of patients suffering from post-traumatic epilepsy. Several substitutes for the normal dura were suggested either to prevent the reformation of adhesions broken up at secondary operation or such formation at the time of the operation on the original wound. Brun² discussed this subject in relation to four cases of cortical epilepsy and found no satisfactory solution of the difficulty. Jeger,³ in 1916, employed transplants of fascia to close such defects. von Eiselsberg,⁴ in a general report before the German Surgical Congress of the same year, discussed post-traumatic epilepsy and particularly with reference to the prevention of adhesions between the brain and its envelopes. He referred to the use of implants of fat, of omentum, and of celluloid plates. Neuhof,⁵ in 1920, in a discussion of fresh injuries of the brain, reported a number of instances where fascial transplants had been used by him for the closure of dural defects, and Kerr⁶ the same year advocated the inversion of cranial bone transplants, thus bringing the periosteum next to the cortex in order that, in a certain sense, it might replace the absent dura.

All substances, even autogenous grafts, may be fairly assumed to be but poor substitutes for the normal dura, and it is indeed doubtful if they act in any other manner than as a scaffolding for the ingrowth of new tissue. Denk, as quoted by Neuhof,⁵ examined such a fascial transplant eleven months after the operation and found it transformed largely into dense fibrous tissue, apparently as the result of gradual disintegration with simultaneous

* The substance of this paper was submitted by William Y. Sayad as a thesis for the degree of Doctor of Medicine, Yale University.

tissue replacement. He stated that it is evident that the fate of the transplanted fascia is unknown and that the possibilities are in favor of its ultimate death.

That there is a certain appreciation of this probability is evidenced by current civil practice where one rarely sees the neurological surgeon attempt to reconstruct the dura with

such substances. There has grown up a feeling, based on clinical experience, that the dura takes good care of its own defects and that the introduction of foreign bodies only increases the adhesions. Trotter⁷ goes so far as to say that of all the membranes of the body the dura is the one which is most certainly and rapidly reformed after partial excision and as he has observed at secondary operation, such defects invariably and completely heal in a few weeks, and are scarcely to be distinguished from the normal. The regenerated dura possesses the three characteristics of the normal dura; that is, the glistening inner surface, the extreme density, and the differentiation from the overlying structures.

Reasoning from analogy one need not be surprised at the statements of Trotter. The peritoneum closes any defect in its surface rapidly and many times without adhesions. Experimentally Vogel⁸ has observed closely its healing and has found, that, provided a single area is destroyed in such a manner that raw surfaces do not come in contact, the regeneration of the peritoneum is rapid and its normal continuity soon established. The canalization of thrombi by endothelial lined spaces and the efforts at regeneration in chronic obliter-

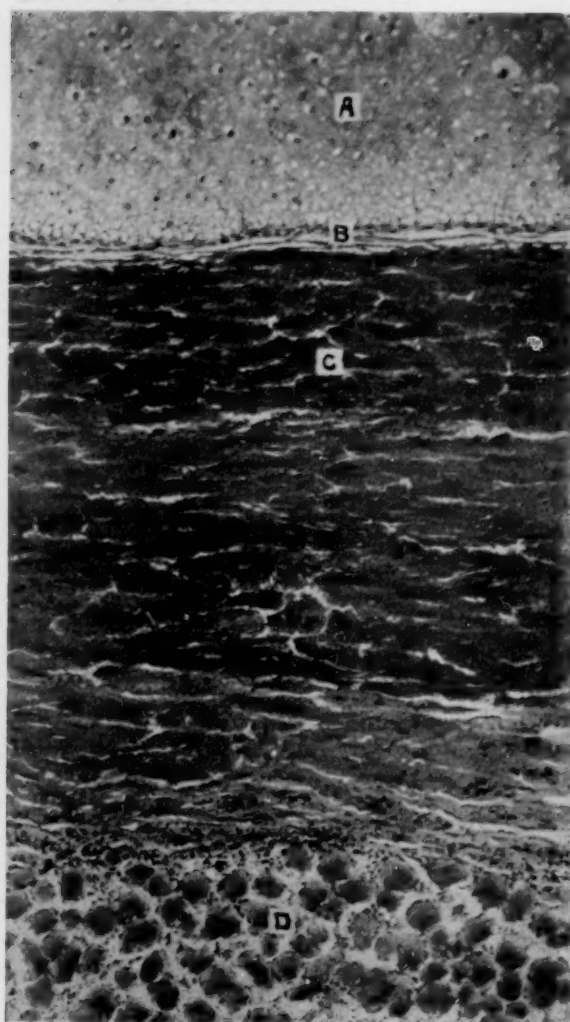


FIG. 1.—Protocol I, sixty hours. A—Normal brain. B—Normal pia and arachnoid. C—Blood clot. D—Temporal muscle.

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REGENERATION OF MENINGES

ative pericarditis also would suggest that the endothelial or mesothelial lined membranes of the nervous system might well make similar efforts at repair.

That such healing may take place without the formation of adhesions is not so apparent and, indeed, judging from clinical experience, adhesions are most frequent sequelæ. Marchand⁹ goes so far as to say that the formation of adhesions is a necessary concomitant of the healing of the dura.

In view of the somewhat divergent opinions, it seemed worth while to subject the healing of the dura to experimental investigation. The healthy adult dog was chosen as the subject and the following procedure carried out. Under ether anæsthetization the temporal muscle was reflected downward in such a manner as to expose adequately the parietal bone. A button of large size was removed with the crown tre-

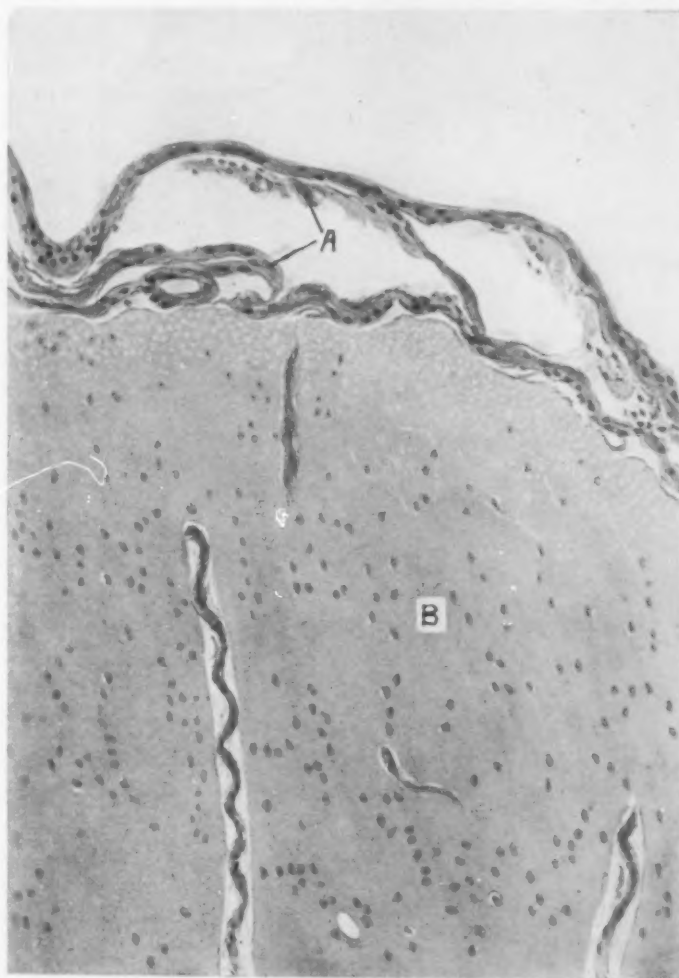


FIG. 2.—Protocol I, sixty hours. A—Pia and arachnoid. B—Brain, showing the absence of trauma and consequent cellular reaction.

phine and the dura beneath carefully excised, particular care being taken not to injure the arachnoid and pia. The area removed was accurately determined by Douglas'¹⁰ method for the measurement of wounds. The dura and bone defect were allowed to fill in with blood clot, the temporal muscle carefully sutured in place with interrupted silk and the remainder of the wound closed in layers. After the time interval determined upon, the animal was sacrificed and the brain fixed *in situ* by the injection of formalin through the carotid

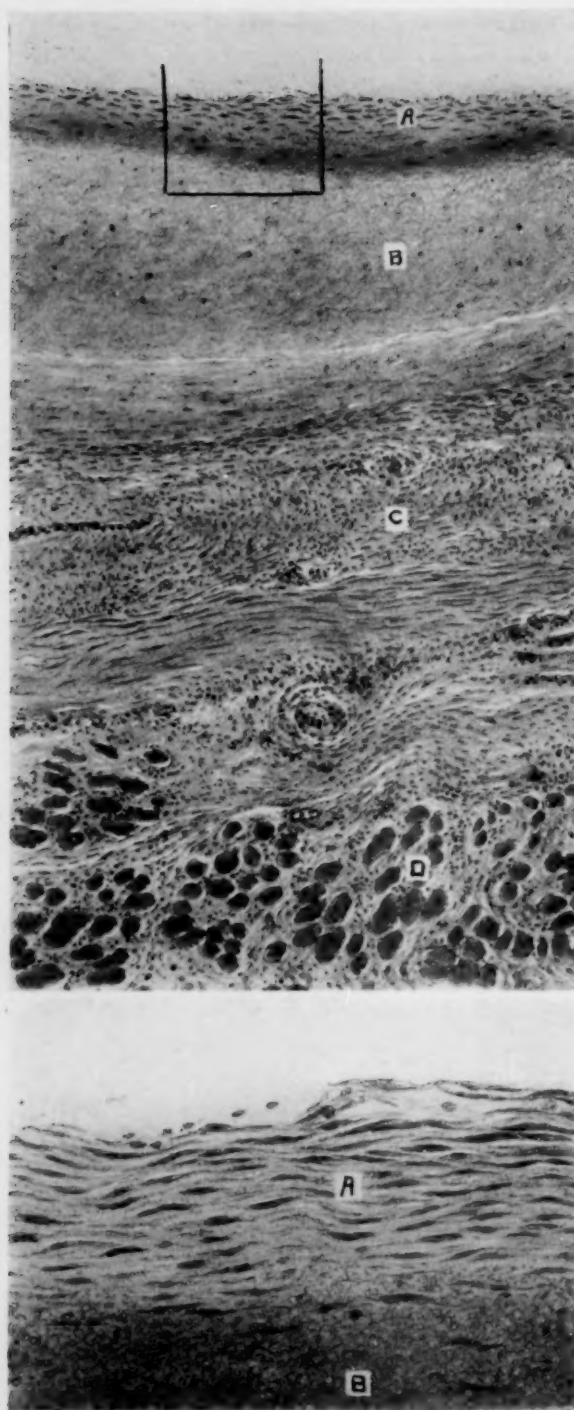


FIG. 3.—Protocol III, fourteen days. A—Cells lining new dura. B—Remains of blood clot. C—Connective tissue layer of new dura. D—Temporal muscle.

arteries. The tissues surrounding the wound, including the adjacent brain, were then removed *en bloc* and studied with particular reference to the presence of adhesions, the appearance of the arachnoid and pia, and the character of the newly formed structure occupying the dural defect. Sections for microscopic studies were made from suitable blocks and stained with hæmatoxylin and eosin. The protocols of these experiments are as follows:

Protocol I:—Dog 4:—
Operated upon January 23, 1921 and 2.8 sq. cm. of dura removed. The animal died in 60 hours from causes not related to the operative procedure, and was autopsied two hours later.

Gross Examination.—
There was no exudate or other signs of infection of the wound. The brain beneath the dural defect was found to be closely adherent to the overlying blood clot which was about 2 mm. in thickness. The latter was likewise adherent to the overlying temporal muscle.

Microscopic Examination.—The cortex of the brain immediately adjacent to the dural defect was quite normal, in particular there was no evidence of hemorrhage or inflamma-

REGENERATION OF MENINGES

tory reaction. The pia and arachnoid were clear of any signs of injury, but immediately and intimately related to the arachnoid was the blood clot as described above. It had the appearance of any blood clot with beginning organization. There was no invasion of phagocytes, wandering, or polyblastic cells from the arachnoid surface, but from the side of the temporal muscle many mononuclear cells resembling those seen in the blood stream were passing inward toward the deeper portion of the clot. Accompanying these were a few polymorphonuclear neutrophils and an occasional lone cell with faint staining single nucleus and a large amount of cytoplasm. Phagocytosis had not yet taken place to any great degree. The cells were distributed in much greater number at the edge of the muscle and grew proportionately less the closer one came to the arachnoid surface. The muscle itself showed a considerable amount of oedema with fibrin and red blood cells along the line of incision. The picture was that of an early resolution of a blood clot in which the cellular infiltration was proceeding from the muscle surface and not from the arachnoid which itself seemed quite normal.

Protocol II:—Dog No. 12:—Operated upon March 8, 1921, and 3.45 sq. cm. of dura removed. The animal was sacrificed seven days later and autopsied within four hours.

Gross Examination.—The wound was thoroughly and cleanly healed. The brain was not adherent at the site of the operation and during preparation dropped away from the new dura. Over the excised area were seen remnants of thin blood clot covered with a smooth glossy surface directly continuous with the adjacent dura. This new tissue was thin and through it the edges of the trephined bone could be seen.

Microscopic Examination.—The brain showed no areas of hemorrhage and no cellular infiltration. The pia and arachnoid were quite normal in appearance throughout, and there was no evidence of adhesions. The blood clot had in a large degree undergone organization. There was still remaining some of the hemorrhage which was being rapidly taken up by phagocytic cells. Scattered throughout the section and particularly along the edge of the temporal muscle were large macrophages filled with broken-down blood pigment. At this latter point there were also a few minute pieces of bone, one or two of which were surrounded by giant cells. These were undoubtedly broken off at the time of the operation and included in the blood clot. Between the temporal muscle and the free surface of the section the tissue was made up in considerable part of fibroblasts, those nearer the muscle already having laid down numerous fibrils. There were many newly formed blood-vessels, which became less frequent as the cerebral surface was approached. All these new cells were laid with a remarkable uniformity in a plan parallel to this surface. As one approached the meningeal side of the section one encountered with greater frequency cells with large, elongated, faintly stained nuclei and a considerable amount of cytoplasm, many of which showed no tendency to fibril formation, thus suggesting their origin as from the wandering or polyblastic cell. At the surface itself there was a definite lining membrane or plate of cells which was certainly of an endothelial type. This seemed to form a perfectly smooth uniform surface which was quite similar to that of the endothelium of the normal dura. There was no evidence of adhesion formation and the approximation in appearance to the normal dura was quite remarkable. Throughout the section there were present, of course, all the varying types of polyblasts that one sees in granulation tissue anywhere.

Protocol III:—Dog No. 13:—Operated upon March 14, 1921, and 3.66 sq. cm. of dura excised. The animal was sacrificed fourteen days later and the carotids injected with formalin immediately.

Gross Examination.—The brain or its envelopes were nowhere adherent and presented normal surfaces even adjacent to the area of the excised dura. Over this area of excision there was present on the dural side a shiny, smooth, thin layer of tissue perfectly continuous with the edges of the attached dura. Beneath this could be seen shining through, small areas of old blood clot. This new tissue was of course adherent to the overlying temporal muscle.

Microscopic Examination.—The brain seemed normal in every respect. There was no sign of injury or inflammatory reaction. The pia and arachnoid could not be distinguished from those of the normal brain. In particular, there was nothing to indicate the presence of adhesions. Overlying the temporal muscle in the area of the newly generated tissue there seemed to be adjacent to the muscle a well developed young connective tissue overgrowth. Bundles of cells ran in various directions and most of them seemed to be particularly oriented parallel to the free surface while there were no bundles seen running perpendicular to it. At one corner of the section the old endosteal portion of the dura was turned back upon itself and became directly continuous with the newly formed fibrous tissue.

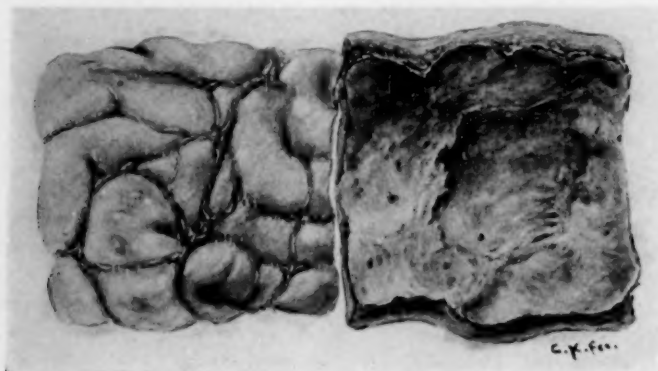


FIG. 4.—Protocol VI, twenty-eight days. Gross appearance of brain and newly formed dura.

Over a considerable portion of the section there was a layer of old blood clot still undergoing the process of organization. There would seem to have been in this case a much larger blood clot formed than in the previous one and consequently the resolution in some places was not as complete, even though the dog lived a week longer. However, on the free surface throughout the section and directly continuous with the endothelial lining of the dura proper was a plate-like layer of endothelial cells, the only difference from the normal dura being that in this region it was several cells deep. This layer was continuous into the contiguous portion of the blood clot itself, and there it gradually thinned out so that these cells became isolated. As in the previous section there were cells with rather faintly staining nuclei but large and elongated, and with a considerable amount of cytoplasm which did not yet show fibril formation. In the deeper layers, however, it would have been difficult to distinguish these cells from young fibroblasts, but in the superficial layers they had the same appearance as those found over the normal dura. Otherwise the tissue was not remarkable, showing the same cellular constituents and blood-vessel growth that would be seen in the organization of a clot at this stage elsewhere.

Protocol IV:—Dog No. 11:—Operated upon March 5, 1921, 3.46 sq. cm. dura being excised and immediately fixed with formalin. The animal was sacrificed fifteen days later.

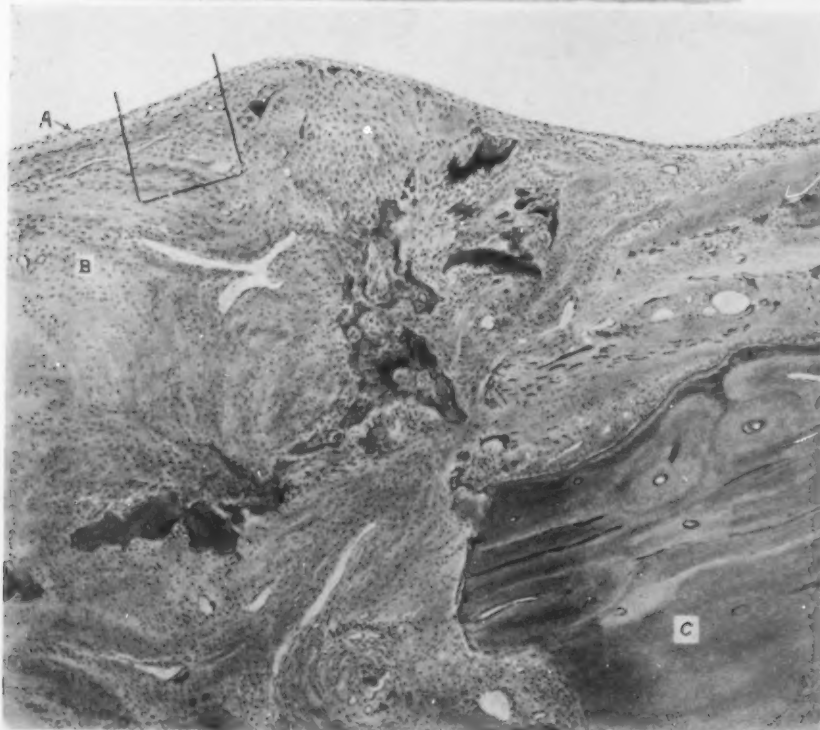


FIG. 5.—Protocol VI, twenty-eight days. A—Newly formed lining of dura. B—Connective tissue of new dura. C—Bone of skull at edge of trephine opening.

Gross Examination.—The brain was not adherent to the overlying dura and shelled out spontaneously with no gross evidence of adhesions. The pia and arachnoid layers appeared normal. Over the area of the excised dura there was present tissue of the same glistening appearance as the surrounding dura. It was somewhat more whitish and appeared also thicker but otherwise did not differ from it markedly.

Microscopic Examination.—The brain appeared perfectly normal in every respect. Neither it nor the pia and arachnoid showed any signs of hemorrhage or of inflammatory reaction. There were no adhesions. The newly formed membrane was somewhat thinner than the one in the previous protocol but made up of more condensed tissue. There was evidently a smaller blood clot and an earlier resolution. On the temporal side adjacent to the excised bone there was a considerable area of cellular infiltration with phagocytic and giant cells grouped around a greater number of loose fragments. Between this, however, and the cerebral surface and directly continuous with the endosteal layer of the dura there was a solid layer of young connective tissue with many new blood-vessels

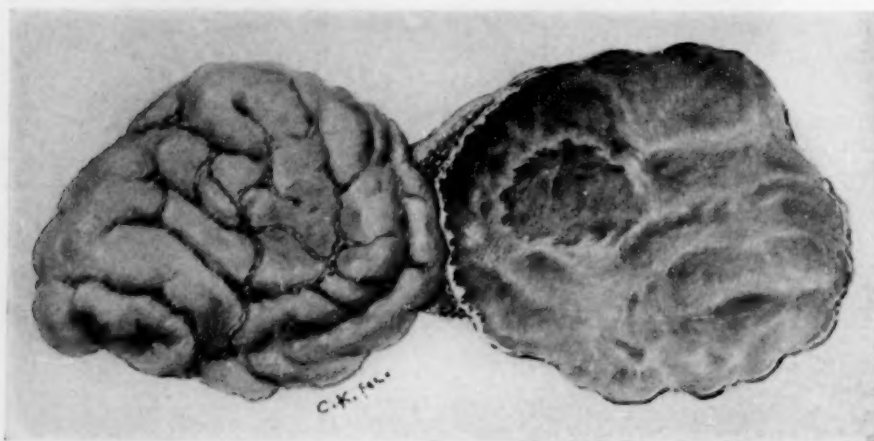


FIG. 6.—Protocol VII, thirty-five days. Gross appearance showing repair of dural defect.

running through it. There was scarcely any evidence of the old hemorrhage except the few large phagocytic cells filled with blood pigment. On the surface and directly continuous with the endothelial layer of the old dura was a plate-like layer of endothelial cells two or three deep. These could not be distinguished from those of the normal dura and were scarcely different from the adjacent connective tissue. In this section there seemed to have occurred a higher degree of differentiation, and the result was a membrane approximating very closely that of the normal dura.

Protocol V:—Dog No. 10:—Operated upon March 2, 1921, and 4.24 sq. cm. of dura excised. The animal was sacrificed 22 days later and immediately injected.

Gross Examination.—The brain shelled out of its own accord, and there were no adhesions present. The pia and arachnoid were perfectly normal in appearance. The defect in the dura was completely filled with newly formed tissue to which the temporal muscle was adherent. The new tissue had much the same appearance as the surrounding dura, being very smooth, and glistening in appearance, but somewhat more white and opaque.

Microscopic Examination.—The brain and its membranes immediately adjacent were entirely normal. There was no evidence of any reaction to injury and no

REGENERATION OF MENINGES

adhesions were present. In the temporal muscle and at the edge of the trephined bone there were many bone fragments surrounded by foreign body reaction on the part of the tissue. Otherwise the appearance was much the same as seen in the last section except that the newly formed tissue was still more condensed and contained, particularly on its free surface, a great number of vessels, many of which were of large size and had extremely thin walls. The connective tissue appeared distinctly older than in previous experiments but was still in large part arranged tangentially to the surface. There was a layer of endothelial cells, two or three deep, quite sharply differentiated from the underlying fibroblastic tissue, and forming the surface of the membrane. The appearance was that of the ordinary healed scar of the same age, aside from the endothelial lining which approximated very closely that of the normal dura.

Protocol VI.—Dog No. 6:—Operated upon February 2, 1921, and 6.13 sq. cm. of dura removed. The wound was superficially infected but with careful treatment was induced to heal in about 3 weeks. The infection at no time extended

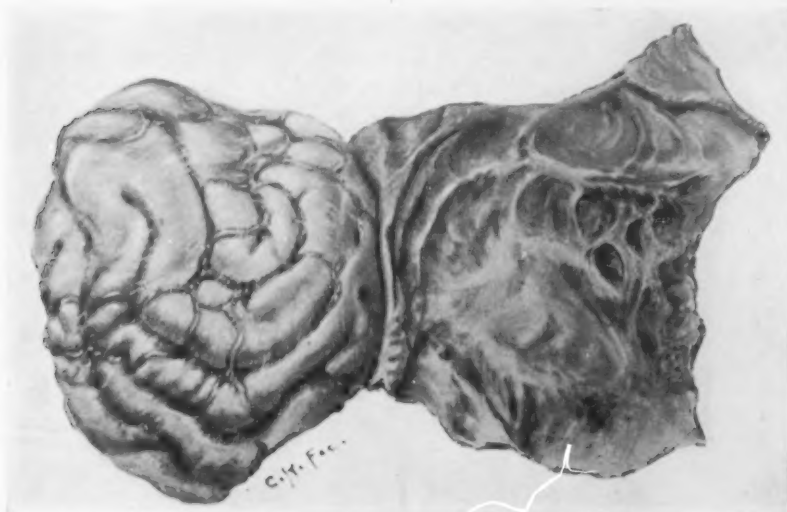


FIG. 7.—Protocol VIII, forty-three days. Gross appearance showing repair of dural defect.

beyond the superficial layers. The dog was killed 28 days after the operation and the head immediately injected.

Gross Examination.—On isolating the specimen the brain shelled out spontaneously. The surface was quite normal in appearance and the arachnoid was smooth and showed no evidence of adhesions. The dura had completely regenerated and was to be distinguished from the surrounding normal dura only by a somewhat thicker appearance. The surface was smooth and glistening and there were no adhesions present.

Microscopic Examination.—The brain showed no abnormality. The pia and arachnoid gave no evidence of previous injury. There was no inflammatory reaction or old hemorrhage and no adhesions were present. In this section the connective tissue had quite an adult appearance. It was arranged in whorls but in greater part tangential to the free surface. The cellular reaction to injury had largely subsided and there was present little else but fibroblastic tissue. The free surface was directly continuous with that of the normal dura and the endothelial layer, somewhat thinner than previously seen, was only one or two cells deep in

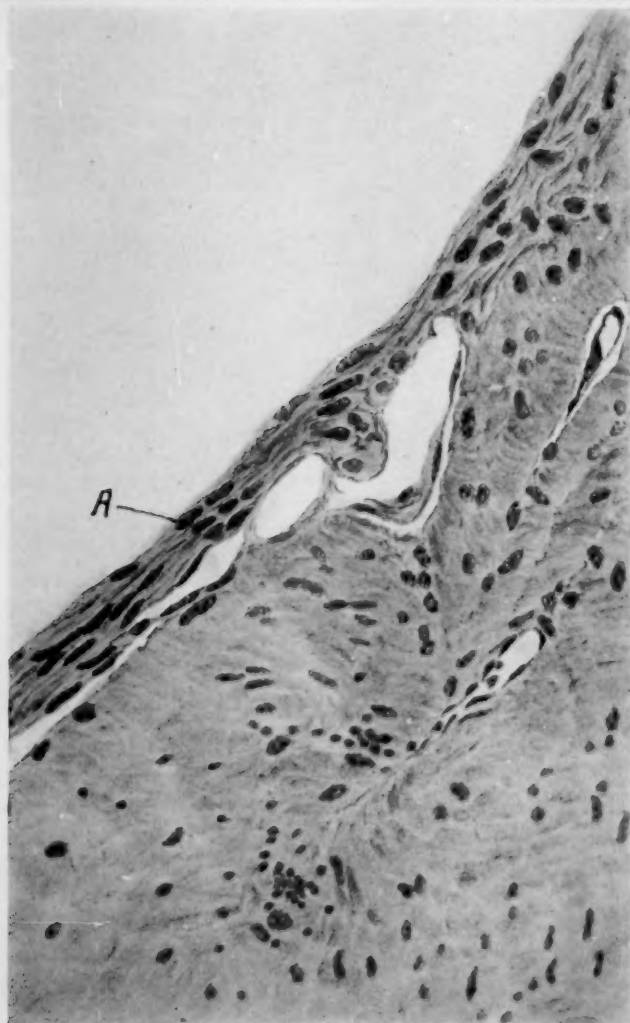
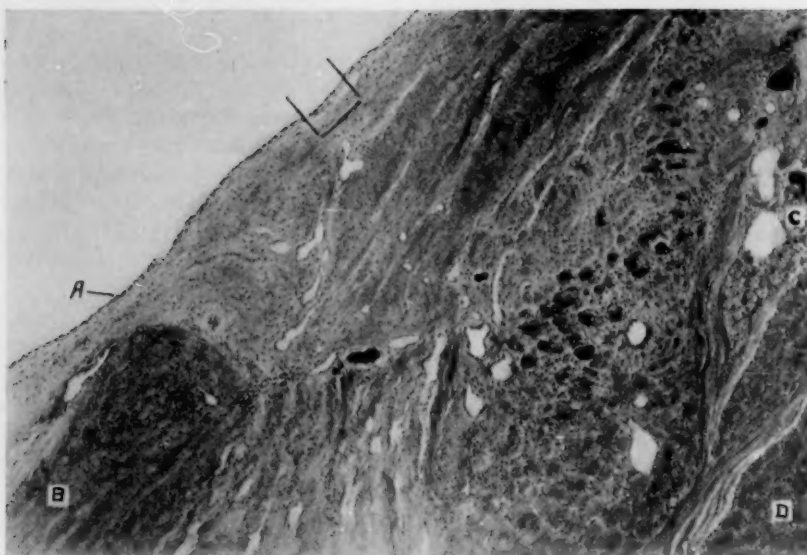


FIG. 8.—Protocol VIII, forty-three days. A—Newly formed endothelial lining of dura. B—Newly formed connective tissue layer of dura.

REGENERATION OF MENINGES

places and easily torn off by the sectioning of the tissue. It did not differ in any respect from that of the normal dura. There were beneath it in several places large newly formed blood spaces so that the new dura was very distinctly more vascular than the old. The process of healing seemed to be practically completed.

Protocol VII:—Dog No. 5:—Operated upon January 31, 1921, and 4.38 sq. cm. of dura excised. He was killed thirty-five days later and the head immediately fixed.

Gross Examination.—In the case of this specimen the brain shelled out spontaneously with no evidence of adhesions. Grossly it and its covering meninges appeared normal. The dura itself had completely regenerated, only appearing somewhat more opaque than the dura elsewhere and perhaps somewhat more vascular. The surface was quite smooth and glistening and showed no evidence of adhesions.

Microscopic Examination.—The appearance was not essentially different from that in the previous section. The amount of connective tissue seemed to be somewhat less and it was in large part adult connective tissue, immediately and intimately adjacent to the overlying muscle. There were many blood spaces and the process of regeneration was practically complete. Over the free surface there was a distinct plate-layer of endothelial cells two or three deep and definitely differentiated from adjacent connective tissue. Aside from the lack of regularity in the laying down of the connective tissue the new membrane did not differ essentially from the dura elsewhere.

Protocol VIII:—Dog No. 3:—Operated upon January 5, 1921, and 3.57 sq. cm. of dura removed. The dog was killed 43 days later and the head immediately injected with 20 per cent. formalin.

Gross Examination.—The brain shelled out spontaneously and with no adhesions. The appearance of the overlying meninges did not differ from the normal. Over the area of absent bone the dura was found scarcely to be differentiated from that elsewhere, it having the same glossy appearance and texture as the ordinary dura. It was intimately adherent to the temporal muscle.

Microscopic Examination.—The brain, pia and arachnoid were perfectly normal. The newly formed dura had much the appearance of the normal dura. It was immediately continuous with the temporal muscle on its outer surface and in one or two places there were present giant cells undoubtedly induced by some small bone fragments. The connective tissue layer was quite condensed and had every appearance of being adult connective tissue. There were a few blood spaces but the tissue as a whole was not nearly as vascular as that seen in the previous section. It was covered by a layer of endothelium only one or two cells deep and so fragile that it was in many places torn loose from the section, and corresponded in appearance to the endothelial lining of the normal dura.

Discussion.—From the findings as given in detail in the above protocols, one may gather the process of regeneration of the dura to be as follows:

The operative defect is filled at once by blood clot which on its inner face is lightly adherent to the arachnoid and on its outer intimately adherent to the exposed temporal muscle. The process of organization of the clot commences at once and takes place much in the same manner as it would elsewhere in the body. There is an immediate invasion of phagocytes, followed almost at once by wandering and polyblastic cells and then in time by fibroblasts. These all appear to come in large part from the overlying temporal muscle and to be evenly distributed throughout the clot. Those reaching

the inner surface adjacent to the arachnoid membrane become arranged in a plane tangential to that surface, and at sixty hours there is a distinct skeletal arrangement of the cells corresponding to the future architecture of the dura. In something less than a week certain of these cells are arranging themselves along the inner face of the blood clot in contact with the arachnoid, so that one begins to see a limiting membrane resembling the endothelial lining of the normal dura.

Whether these cells are derived from wandering cells, from polyblasts, or from fibroblasts is a matter that can only be determined by a long and detailed study of the special staining reactions. MacCallum¹¹ described the transition of young connective tissue cells into endothelial-like cells lining an infected space in the muscles of the neck of a dog and referred to the manner in which connective tissue lining any cavity, such as a newly formed bursa, may form a lining membrane. He was skeptical, however, as to this membrane ever becoming true epithelium. Aschoff¹² was likewise doubtful as to the occurrence of such a metaplasia. It is highly probable, however, from these experiments, that the endothelial or endothelial-like lining seen at this early period is derived from cells coming from the muscle side of the clot and not by the ingrowth of endothelium from the cut edge of the dura.

This surface is then complete in about a week and at this time the clot loses its fibrinous adhesions to the arachnoid. From this time on the process is largely one of growth and condensation of connective tissue behind the lining cells. These bundles of fibroblasts are laid down in a plane tangential to the arachnoid and the newly formed endothelial layer.

It is apparent that this healing takes place without the formation of adhesions and a study of the process detailed above explains this. The cells invading the blood clot do not come from the arachnoid, because as there is no injury to that membrane it is impervious to cells, certainly in any appreciable number. Rather they traverse the clot, and on reaching its inner surface come to the normal arachnoid against which they flatten themselves, thus forming the new endothelial lining of the dura. The fibroblasts are in a similar circumstance and consequently there is no growth of these into the arachnoid, which is essential to the formation of an adhesion. It is apparent that the injury of the endothelium of the arachnoid, either mechanically or in any other manner, would allow such penetration and bridging of the organizing cells and consequently lead to adhesions.

The clinical application of this problem is apparent. If the endothelial covering of the arachnoid is kept intact the dura will regenerate and fill its own defect, and that, moreover, without adhesions. If necessity or carelessness leads to the destruction of the endothelial lining of the arachnoid, then the dura will regenerate, but with its connective tissue largely adherent to the adjacent layer of the arachnoid and pia and with many adhesions.

Summary.—Defects in the dura of the dog operatively induced, without injury to the adjacent arachnoid, heal rapidly in from one to two weeks and without the formation of adhesions.

REGENERATION OF MENINGES

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CHRONIC EMPYEMA

ITS ETIOLOGY, PATHOLOGY, DIAGNOSIS, COMPLICATIONS, TREATMENT
AND FINAL RESULTS

By CARL EGGERS, M.D.
OF NEW YORK

THERE is probably no suppurative inflammation of any part of the body, except that of bone, which leads to chronicity as frequently as inflammation of the pleura. The reason for this is that in addition to the element of infection, there are mechanical factors concerned. These factors are negative air-pressure within the closed thorax, mobility of the mediastinum and diaphragm, a rigid thoracic wall, and the development of an open pneumothorax, when the chest is opened. Failure to recognize the importance of these, and to consider them in the treatment of the acute stage of the disease, may lead to the development of chronicity.

As pointed out in former articles on acute empyema * there are so-called typical cases, usually following lobar pneumonia, of pneumococcus origin, in which the pus settles by gravity in the lower thorax, on the outer surface of the lung, and becomes walled off there. Drainage of such a case will usually lead to cure in a short time without any difficulty. The chief point to be considered is to make a good opening at the dependent part of the cavity. Healing of such a case may be hastened by irrigation and artificial sterilization. If the disease becomes chronic, it can usually be traced to some gross error in technic, or to failure to recognize simple surgical principles, and it can truly be said of such a chronic case, that it was avoidable.

There are, however, many cases of acute empyema which differ from the so-called typical case. These are more often found in the streptococcus infections, but also in pneumococcus infections which follow a secondary or broncho-pneumonia. The exudate in these cases may be very extensive, it may surround a lung, it may be partly situated in the mediastinum, or it may become encapsulated where access to it is difficult. There may be adhesions, either old or recent, that divide the cavity into several compartments, and may lead to separate cavities or recesses. There may have been a perforation of an intrapulmonary focus leading to a pyo-pneumothorax. The case may be one of latent tuberculosis with acute influenza and pneumonia grafted on top of it. It may be a real tuberculous empyema, with a secondary infection, not recognizable in its true light at the time. Any of these cases present problems, sometimes difficult to solve, and it is not always easy to foresee all possibilities. The aspect of a case during the acute disease is quite different from that a few months later, when it has become

* Empyema-Analysis of 70 Cases at Base Hospital, Camp Jackson, Carl Eggers, Surg., Gyn. and Obst., April, 1919. Relative Value of Various Operative Procedures Employed in Acute Empyema. Carl Eggers, Journal A. M. A., October, 1920:

CHRONIC EMPYEMA

chronic. One may consider it safer in a badly septic case to make a good opening, even at the risk of getting a collapse of the lung, simply animated by the one feeling, to save life. We know that such a collapse can usually be avoided by the institution of closed drainage. On the other hand, I have seen collapse of the lung occur in the presence of a perfectly functioning closed drainage.

Chronicity in all these different types, if due to gross errors in judgment, or to failure to recognize causes, or failure to apply good surgical principles, is also to be classed as avoidable. On the other hand, there are some cases of acute empyema which from the very beginning show a tendency to become chronic, or which in the course of treatment develop conditions that are beyond control or not easily avoided. For this reason I have come to divide all chronic empyema cases into avoidable and unavoidable.

There is perhaps no disease in which continuity of treatment is more important than it is in empyema. Those surgeons therefore who perform their own operations and themselves carry out the after-treatment, or at least closely supervise it, will have better results than others. In many hospitals it is still a common practice to discharge empyema patients before they are completely healed. This may be at their own request, or because it is believed the treatment can be successfully continued in an out-patient department. With this necessitated change in treatment by a man not familiar with the details of the case, and with the increased liability to secondary infection in out-patients, the tendency to chronicity is increased.

The fact remains that quite a number of patients with this condition present themselves for treatment, and in order to treat them intelligently it is necessary to understand the causative factors and to be familiar with the pathology of the disease. Chronic empyema is a serious condition, requiring careful individual attention, and ingenuity, resourcefulness, patience and the application of sound surgical principles are demanded in order to bring many of these patients to complete cure.

During the war the importance of empyema in general, and later of chronic empyema, was early recognized by the Medical Department of the Army. It became the policy of the Surgeon General to collect patients with this condition in special hospitals, where they were put in charge of officers trained to care for them, or who showed enthusiasm and aptitude in the treatment. These officers therefore had an unusual opportunity to study the condition and to record their findings. It was my good fortune to be put in charge of one of these concentration places for chronic empyema, and during the last few months of my army service to be ordered by the Surgeon General to visit nearly all hospitals in which chronic empyema patients were treated. The observations made in this way, together with those in civil practice, form the basis for the opinions expressed in this paper.

During a four months' period in charge of the surgical service at U. S. General Hospital No. 12, at Biltmore, N. C., 192 patients with chronic empyema came under my immediate care. They are the ones chiefly

referred to in this paper. Under the policy mentioned above eighty patients had gradually been collected at this hospital previous to my arrival. Most of them had just recently come in, while a small number had been under treatment there for a long time. In the next few weeks following my arrival 112 additional cases were admitted. A few patients were healed and were simply awaiting the required standard as to weight, length of time since healing, etc., we had set as the minimum for justifying release from the Army. All other patients had discharging sinuses. Some of them were in

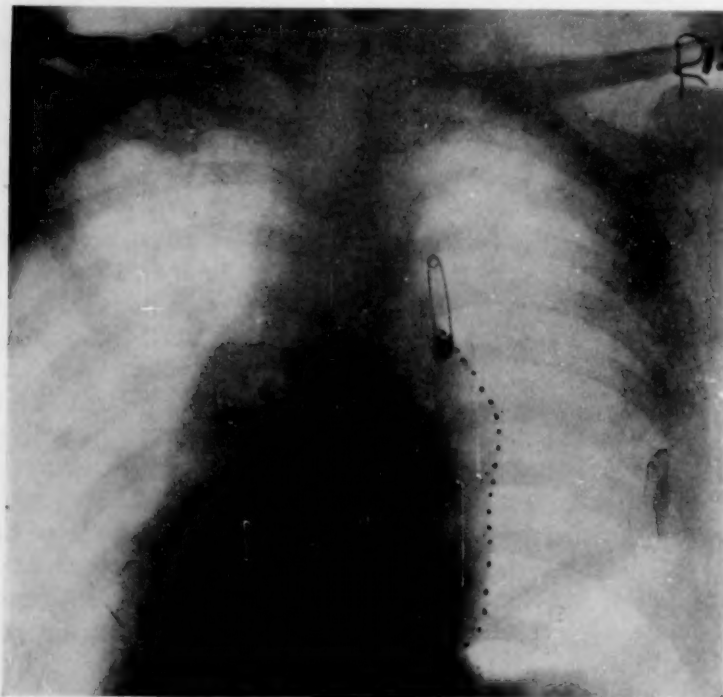


FIG. 1.—Showing absolutely collapsed lung in a case with a very extensive exudate unrecognized for two years.

very good physical condition, ambulatory, and able to stand exercise, while others were underweight, and still others in a septic state, confined to bed. In some patients it was simply a slight obstacle to healing that prevented their complete cure, while others had deep sinuses or cavities requiring long and careful attention.

Of the 192 patients, 170 were white and 22 colored. All were of military age. A few had their primary operation performed at this hospital and had since been on Carrel-Dakin treatment, but by far the greater number had been operated on at some other Army Hospital in the United States or had been returned unhealed from over-seas. They would usually arrive in groups of from four to twenty, representing the total empyema residue of their respective camp.

CHRONIC EMPYEMA

Questioning brought out the fact that these men had had essentially the same treatment as hundreds of their colleagues, who had in the meantime been discharged cured. Such statements would tend to disprove that chronic empyema is always or nearly always avoidable. They seemed to show that in these particular cases, those which had become chronic, some element was present which was overlooked in the routine treatment of cases or which resisted treatment. We set ourselves the task to determine whether the treatment given at any particular camp was more likely to be followed by chronicity than the treatment given at another camp. We learned in this way that nearly all the cases had been on Carrel-Dakin treatment, in some camps given in the prescribed manner, in others only one or two irrigations a day. Whether this treatment had been started immediately after operation or several days later, seemed to make no difference. The same thing held true in regard to the type of operation done. Of our cases 131 had rib resection done, and 61 some form of intercostal drainage, either trocar or stab incision. The impression gained ground that no matter what operation was done, whether a trocar catheter drainage, an intercostal incision, or rib resection, and no matter what treatment was used, whether simple drainage, regular Carrel-Dakin or irregular Carrel-Dakin treatment, a certain number of cases would become chronic. The information obtained in this way did not give us any definite findings.

I believe all these factors play an important rôle in acute empyema, not alone in regard to whether a patient lives or dies, but whether his convalescence will be short or long. In regard to the development of chronic empyema their rôle is less important except in one respect, namely, imperfect or inadequate drainage, which no matter what treatment has early been used, tends to chronic cavity formation. It is not enough to make a good opening in acute empyema, it has to be maintained.

We then began to look for other possible causes of chronicity. Did the type of pneumonia preceding the empyema, or the type of organism producing it, play any rôle? Investigation showed that the primary disease in these 192 cases was

Pneumonia	44	Bronchitis	4
Broncho pneumonia	12	Vincent's angina	1
Lobar pneumonia	4	Mumps	3
Bilateral pneumonia	7	Measles	12
		Tonsillitis	8
		Laryngitis	1
		Influenza	86
		Rhinitis	1
			—
			116
	67	Gun shot wounds	9

What type pneumonia the group with forty-four cases represented is not certain; however, it is certain that but four cases of the total list are called lobar pneumonia. The pneumonia following the diseases in the second

group is secondary, usually broncho-pneumonia, and if we add these 116 cases to the majority of group 1 we find that most patients had a broncho-pneumonia preceding their empyema. This is important and especially interesting in connection with a report on a series of seventy acute cases of empyema reported by me in 1919 in which I showed conclusively that empyema following a secondary pneumonia is usually more serious and requires a longer convalescence than empyema following a primary lobar-pneumonia.

When we studied the organisms responsible for the empyema in relation to this question, we found unfortunately that in many cases there was no report of the original culture present. However, there was a positive report of hæmolytic streptococcus in sixty-two cases, pneumococcus in six cases, and staphylococcus in three cases. While admitting that such a fragmentary report is not conclusive, it nevertheless shows that streptococcus was the responsible organism in a large number of patients. On admission culture showed a mixed infection in nearly all cases, with streptococcus as the predominating organism.

Taking these two findings together, I feel justified in saying that empyema following secondary pneumonias, especially those due to the streptococcus, are more likely to become chronic than those empyemas following lobar-pneumonia, and due to the pneumococcus. Continuing our investigations we were impressed with the fact, that though we had found the predisposing causes for chronicity, there were local, usually mechanical factors responsible for chronicity in a given case. These I shall take up under their respective headings further down.

Under the heading of chronic empyema may be considered three types of cases. 1. Old unrecognized empyema. 2. Patients who have not healed in the usual time. 3. Recurrences.

1. *Old Unrecognized Empyema Cases.*—That patients with accumulations of pus within one of their pleural cavities may go for months before the condition is recognized is unfortunate, but nevertheless true. If we consider that empyema usually is a complication of pneumonia, and that it sometimes becomes fully developed only late, it behooves us to examine carefully all those convalescent pneumonia patients whose general condition does not improve satisfactorily.

In acute empyema the pus usually collects by gravity in the lower thorax, and with typical signs the detection of massive exudates should present no difficulties. It is surprising therefore that even large collections are sometimes overlooked. A patient came under my care sometime ago who had apparently carried an extensive exudate for twenty-three months. Following an attack of influenza in September, 1918, he had never been well, he complained of cough, weakness and dyspnoea. In spite of this he went to work in the mines and continued until he could no longer stand up. After that his treatment by a private physician consisted of electrical applications over the stomach. When he came under observation in the Public

CHRONIC EMPYEMA

Health Service in New York he showed typical signs of an extensive exudate on the right side, filling the entire thorax. There was no temperature. Repeated sputum examinations were negative for tuberculosis. Exploratory puncture showed pus which on culture grew pneumococcus as the predominating organism. Guinea-pig inoculations proved negative. The exudate was gradually released by means of air-tight drainage, and in the first 48 hours over 3000 c.c. were withdrawn. The lung was found to be absolutely collapsed and has remained so, and the patient is a chronic invalid, still under treatment for obliteration of his enormous cavity (X-ray picture 1). Another patient, No. 28 of the series here reported, had a large exudate for seven months, normal temperature, but a positive streptococcus culture. He had been punctured unsuccessfully fourteen times and been treated for unresolved pneumonia. With our present-day knowledge, and the means for diagnosis at our command, such a thing should not happen.

Pus collections in other but the dependent parts of the thorax, on the other hand, are sometimes very difficult to diagnose. These encapsulated pockets of pus

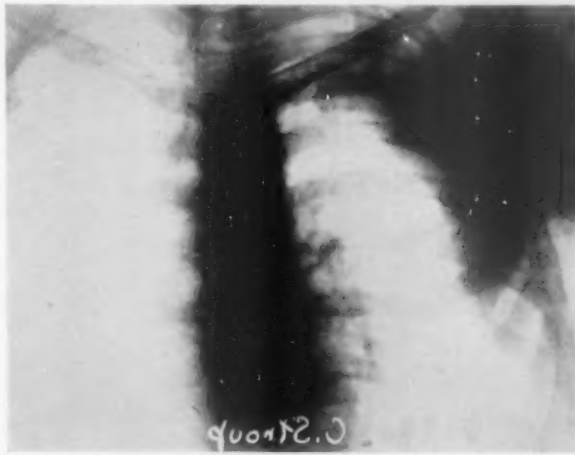


FIG. 2.—Small encapsulated empyema plastered against the upper lateral chest wall.

may be small or large and may be found anywhere within the thorax. They may be situated in the mediastinum, between the lung and the diaphragm, or plastered against the chest wall (Fig. 2). Interlobar pockets also belong in this class. Physical examination is often misleading and exploratory puncture negative. The greatest single aid in the detection of encapsulated pus is the X-ray, preferably a stereoscopic picture. Under guidance of such a plate exploratory puncture is more apt to be successful. The patients so afflicted have often for months after a pneumonia complained of weakness, dry cough, dyspnoea, pain in the chest and loss of weight. They are anæmic and look sick. Sometimes they have been treated for tuberculosis. The pus obtained by aspiration is usually thick, creamy in character, it may be sterile or it may grow organisms in pure culture, even though the temperature has been normal for months.

In the series here reported there were twenty cases in which the diagnosis had been made late, ranging from six weeks to eight months after pneumonia. If left untreated such collections of pus lead to chronic invalidism in one or more ways.

- a. They cause degenerative changes in the organs by septic absorption.
- b. They interfere with respiration and circulation.
- c. They lead to the formation of a rigid abscess wall with a tendency to chronic cavity formation.
- d. They may perforate into a bronchus or externally.

The treatment is the same as that for ordinary empyema, except that the incision must be made wherever the pus is found. It is advisable to resect part of a rib. Of our twenty cases only ten healed in less than three months, while ten became chronic in the sense in which the term is used in this paper, and several later had to have a radical operation, of which one died after an extensive intervention.

Unrecognized chronic empyema may well be put into the class of avoidable cases. During the war it became a rule in some army camps to X-ray every convalescent pneumonia patient before his discharge, a practice which may profitably be adopted by civil hospitals and in private practice.

2. *Patients Who Have Not Healed in the Usual Time.*—The classification of chronic empyema under this heading is an arbitrary one for there is no fixed time in which an empyema should heal. From a study of acute cases it appears that healing usually takes place in from one to three months, with a tendency to a shorter convalescence in the cases following a typical lobar-pneumonia, than in those following a secondary or broncho-pneumonia. For this reason it seems fairly satisfactory to make three months the arbitrary time at which to consider a case chronic. This does not mean that when a patient has not healed in three months there must necessarily be a change in treatment. It does mean, however, that when an empyema continues to drain longer than is usually the case, it becomes necessary to look into the condition very carefully and find out what is the obstacle to healing. It may not be necessary or advisable to do anything except to patiently continue the drainage or irrigation treatment with attention to details. In other cases it may become necessary to remove the condition interfering with healing.

In the attempt to bring about healing, many of our patients had been operated upon several times, as the following table will show:

TABLE I.

No. of operations	1	2	3	4	5
No. of patients	73	67	37	13	2

In spite of this, healing had not taken place, and though some patients had drained but several months longer than the usual time, others had existed well over a year and showed no tendency to heal.

TABLE II.

Length of time of draining.																			
No. of months	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
No. of patients	8	21	25	34	39	15	14	4	7	3	5	2	2	8	3	1	1		

CHRONIC EMPYEMA

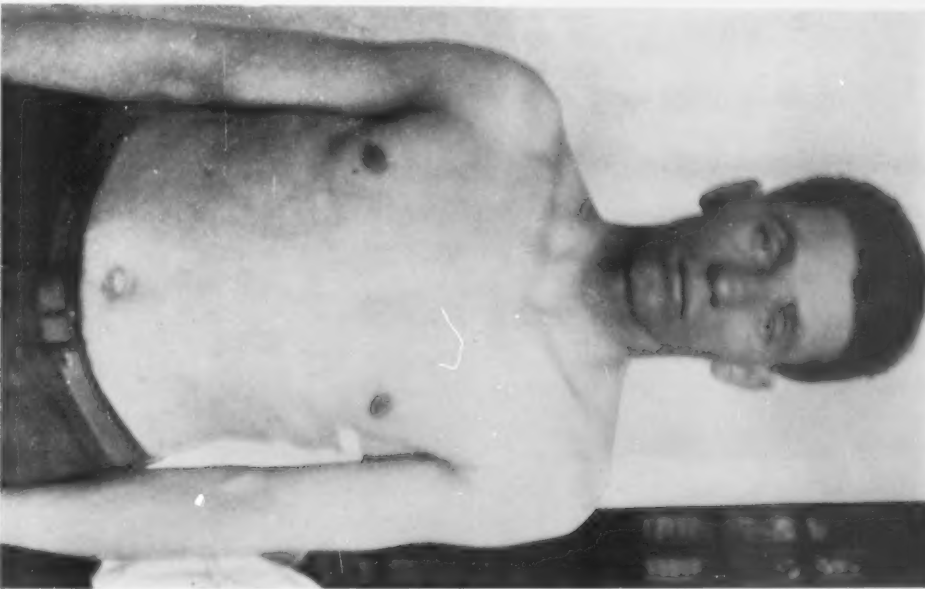
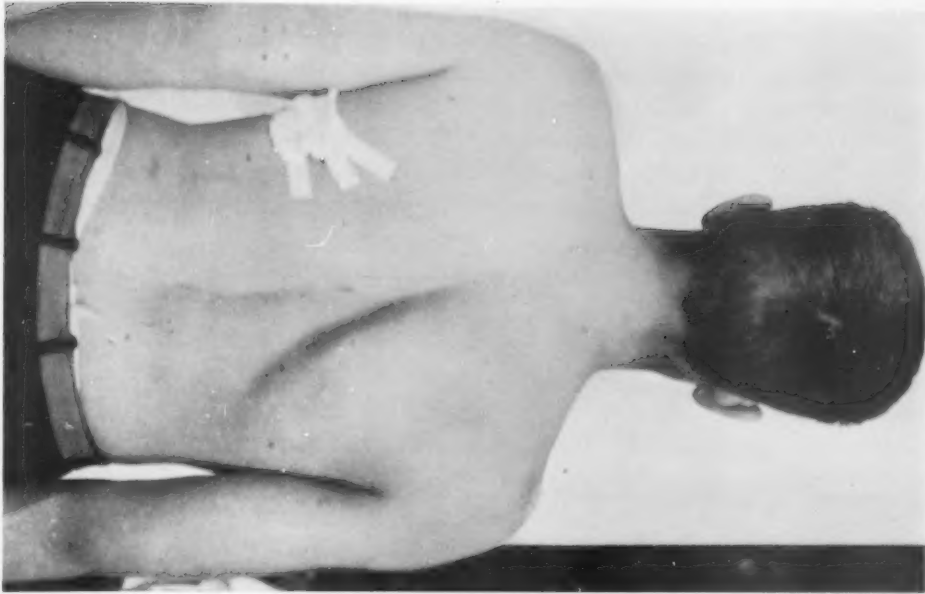


FIG. 3.—Showing deformity in a typical case with repeated recurrences.

The various conditions found in our cases, and interpreted as the causes of chronicity, will be discussed in detail further down.

3. *Recurrences.*—Quite a number of patients give a history that they had healed and reopened while still in the hospital. Others had been discharged healed and were later readmitted with a draining sinus following spontaneous opening of the old empyema wound. Still others came in before rupture had taken place, complaining of pain in the side, temperature, loss of appetite, and perhaps a dry cough. This last group requires surgical intervention, but because of the difficulty in knowing where to go in, it may be well to apply poultices and wait for a spontaneous rupture, which usually occurs through the old scar. What is the cause of such recurrences? There may be different causes, but in a general way it may be said that the longer a case has drained after the original operation, the more apt are recurrences to take place. This is due to the fact that the same causes which originally kept up drainage for a long time, operate to bring about recurrence.

Among our 192 patients there were fifty-nine who had a recurrence at some time in the course of their convalescence. Some of these were not true recurrences in that they occurred within a few days or weeks after healing had taken place, while others had been discharged cured and did not have a recurrence until several weeks or months later. Thirty-one of these patients had been on thorough Carrel-Dakin treatment after their original operation, and had apparently not been allowed to close until the wound was considered sterile, or proven so. Recurrences may occur regardless of the type of primary operation. It makes little difference whether a piece of rib had been resected or whether an intercostal incision was done. Recurrence had taken place because the drainage opening had contracted to such a degree that infectious material was retained, or because of the presence of some intrathoracic cause. These causes will be considered together with those held responsible for chronic empyema in general.

Patients with repeated recurrences often become quite disabled and deformed. Probably owing to pain an attempt is made to fix the thorax, resulting in curvature of the spine, elevation of the shoulder and flattening of the chest (Fig. 3).

Causes of Chronic Empyema and Recurrence.—Realizing that each group of chronic cases sent to us represented but a small residue of perhaps hundreds of cases treated at their camp in the same way, we did not feel justified in arbitrarily saying, they had not been treated right. The question was raised how much of a rôle their own general condition played. It must be conceded that constitutional causes such as syphilis, tuberculosis and anæmia play a rôle, and that complications in other organs will retard healing, but it was usually found that when a case did not heal properly, there was a local cause for it present. Studying any large group of cases of this type brings the conviction that chronicity in some could have been easily

CHRONIC EMPYEMA

avoided, while in others no criticism at all is justified. It always has to be borne in mind that the patient may have been extremely ill during the acute period of the disease and that the best under the circumstances was done.

When we began to study the reasons for delayed healing we found many different conditions, and we soon began to divide the patients into those with: A. Superficial fistulæ. B. Deep fistulæ and cavities.

A. Causes of Superficial Chronic Fistulæ and Their Treatment.—In this group we have put the various conditions that keep up discharge from a superficial focus. The empyema cavity has really been obliterated, but some inhibition in the healing process in the thoracic wall or just beneath it, keeps up a discharge. One condition may exist alone, or two or more may be associated. We have found the following causes to be responsible:

a. Epithelialization of the drainage canal.

b. Infected granulations.

c. Osteomyelitis of a rib.

d. Fistula leading to cartilage.

a. *Epithelialization of the Drainage Canal.*—

Occasionally one sees a case with a deep, drawn-in scar, at the bottom of which a fistula extends into the chest. The tissue surrounding the fistula is hard and rigid, and the fistula itself more or less completely epithelialized. At the bottom of the fistula a few granulations are present that bleed easily when a probe is inserted. The discharge is but slight, but on account of a little moisture constantly present the patient is annoyed. If kept dry by means of powder, healing may eventually take place, but on account of the epithelial surfaces coming in contact during respiration or movements of the body, chafing of the surfaces easily take place, and dried up secretions collect in the depth and give rise to irritation.

b. *Infected Granulations.*—A narrow tortuous canal has remained in many cases after the empyema proper has healed. A little discharge is constantly present. Healing is prevented by the presence of infected granulations along the canal and spreading out beyond under the adjoining ribs. The condition has often been stationary for months, and repeated attempts



FIG. 4.—New formed bone in periosteal bed of formerly resected ribs, and intercostal bridges in cases with intercostal drainage.

to bring about healing by cauterization or even curettage of the tract have been unsuccessful. The reason for this is that the granulations are lodged in the crevices of irregular new-formed bone, and behind it, where they are inaccessible to treatment. Local applications reach only the more superficial layers, while in the depth the infection continues.

c. Osteomyelitis of a Rib.—This condition may be found not alone in those patients in whom a rib has been resected, but also in those with an intercostal incision. In the former case it is easily explained by pus coming in contact with the exposed ends of the rib. A sequestrum may have formed, often very minute, and keep up the discharge. In other cases the new-formed bone may be diseased and be responsible for chronicity. In intercostal incisions the pressure of the drainage tube on the border of the rib above, or below, or both, may lead to erosion and infection. That an intercostal tube does give rise to considerable irritation may be seen by studying the resected portions of bone of such a case, which show grooves and new bone formation in the form of intercostal bridges (Fig. 4). In a recent case, a child with streptococcus empyema, a drainage tube in an intercostal incision led to osteomyelitis of a rib in three weeks.

4. Fistula Leading to Cartilage.—In anterior drainage openings in cases in which a part of cartilage has been resected, one may find a persistent tiny fistula long after the empyema cavity has become obliterated. From time to time it may crust over, only to break down again. Though the condition gives rise to little trouble, the patient worries and his discharge from the hospital is delayed. Investigation shows the fistula leading to the ends of the resected cartilage, where chronic inflammation keeps up the discharge. Applications of caustics have failed to bring about healing.

Treatment.—When these patients come under observation they have often had so much conservative treatment without result, that it is unnecessary to waste time repeating similar procedures. However one may feel like trying. The fistula is usually so narrow that a tube cannot be introduced. In such cases applications of iodine, silver nitrate or pure carbolic may bring about healing. One may also use a small strip of gauze saturated with 5 per cent. dichloramine-T. If more radical treatment is deemed advisable, a curettage of the tract with subsequent local applications may lead to a cure. However, in some cases no results are obtained, and it is then advisable to resort to a more radical procedure, namely complete excision of the entire affected area. This treatment is applicable to the first three groups of cases. The operation may be done under local or general anæsthesia because the patients are in good condition by the time they have a narrow residual sinus, and they have been ambulatory for some time.

Of our series of 192 cases, twelve belonged to this class. The operation is done as follows: An elliptical incision is made well beyond the fistula and completely surrounding it and part or all of the scar. The incision is carried right down to the bone and the muscles and skin are then pushed back. If a

CHRONIC EMPYEMA

rib had been resected at the original operation a bony ring may be found with the fistula passing through to the granulations beyond, while in intercostal incisions one may find more or less complete bony bridges (Fig. 4). Depending on the case, one or two ribs are divided in normal structure, gently elevated to see what is beyond, and the incision then carried into the thickened pleura beyond the granulations. All infected tissue, the skin with the sinus tract, ribs and all granulation tissue with surrounding thickened pleura, is then removed in one piece. If a narrow fistula extends beyond this area, it must also be completely extirpated. By undermining the muscles and skin it is possible to do a complete muscle suture. Often one may turn the cut surfaces inward to obliterate the remaining cavity. A small split rubber drainage tube is inserted between the sutures, and the skin then closed. By this method one not only removes an offending sinus that has caused trouble for months, but one overcomes the local deformity produced by a long draining sinus. Removal of all infected tissue likewise prevents recurrence. The muscle suture will completely overcome any depression at the site of operation and help to restore good function.

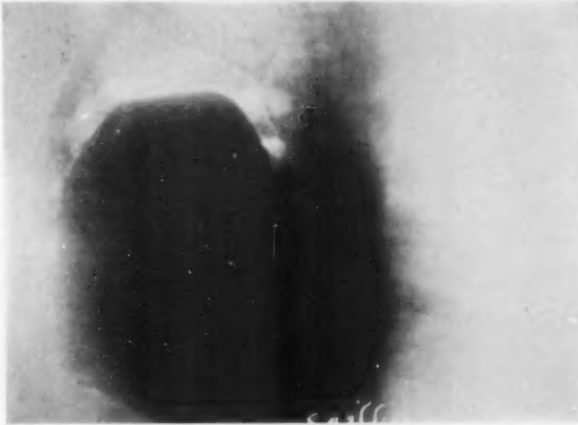


FIG. 5.—Large chronic cavity filled with bismuth.

Of the eleven cases operated upon in this way we obtained the following results: Ten healed in an average of nineteen days; one healed after a long time on account of a bronchial fistula.

The treatment of a fistula leading to cartilage is well illustrated by the following case. Patient F. B., operated on October 15, 1918, for empyema. Part of the fourth right costal cartilage was resected. Three weeks later the eighth rib was resected, posteriorly. This latter wound healed in February, 1919, but the anterior fistula continued to drain. Applications of irritants failed to heal. In March, 1919, an attempt had been made to cure the fistula by operative means, also resulting in failure. In May, 1919, I operated upon this patient. The incision was made in clean tissue, surrounding the fistula, which led to the fourth costal-cartilage. The latter was removed in its entirety, together with a short piece of the fourth rib and a small portion of sternum. The wound was closed without drainage and healed firmly in one week and has remained so. Cartilage heals poorly and it is therefore advisable to resect beyond it in bony tissue.

B. Causes of Deep Chronic Empyema Fistulae and Cavities and Recurrences.—Although frequently considerable distinction is made between a

fistula and a cavity, the two conditions represent but different stages of the same process. The difference between a cavity and a fistula is simply one of size. In the former we deal with a real cavity, which may be small or so large as to occupy the greater portion of the thorax (Fig. 5). In the latter we deal with a narrow contracted cavity, often very long and tortuous and extending sometimes to the apex of the thorax (Fig. 6). Either class of patients represents a condition that has been stationary for months or which progresses very slowly. The amount of discharge may be small or profuse, it may be serous or creamy pus. The opening in the chest wall may lead

directly into a large cavity, or it may communicate with the cavity by a narrow sinus.

What are the reasons these patients continue in this chronic state for months or years? Why do they not heal as others have done? The different causes of chronicity as found in our series are given in the list below and each group is then elaborated upon.

One or more of these conditions may be asso-

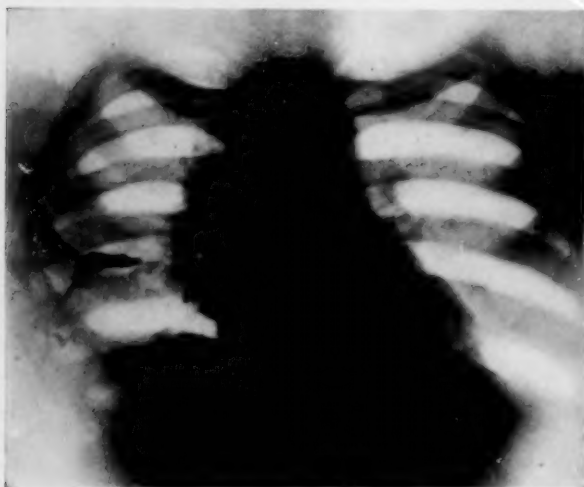


FIG. 6.—Small fistulous cavity with narrow extensions.

ciated. 1. Contracted drainage opening. 2. Improperly placed drainage opening; (a) too high, (b) too low, (c) too far forward. 3. Pockets and recesses. Separate cavities. 4. Infected lining membrane of cavity. 5. Rigid unyielding cavity. 6. Pneumothorax. 7. Bronchial fistula. 8. Foreign bodies. 9. Tuberculosis. 10. Dakin solution. 11. General constitutional conditions.

1. Contracted Drainage Opening.—This is the most common condition found in all chronic empyema cases. No matter whether a rib was resected at the primary operation or whether simply an intercostal incision was made, the opening has finally become so small that a drainage tube cannot be introduced at all, or one so small as to be unable to properly carry off secretions. If cases with an intercostal incision are drained a long time, the pressure of the tube will cause sufficient irritation of the adjoining ribs to stimulate new bone formation, which in time produces bony bridges. As the amount of bone increases, the opening will gradually contract. If the tube is left out for a while, or if its calibre is gradually reduced, no drainage or insufficient drainage is the result. Consequently there is damming back of pus which keeps up the chronic infection of the cavity. A similar condition develops if a sub-

periosteal resection of a rib is done. New and often irregular bone formation develops in the periosteal bed and gradually shuts in the tube and contracts the opening. Unless the precaution is taken to keep the same large calibre tube in place the opening will soon contract to such a degree that imperfect drainage is the result.

Many surgeons to-day use the intercostal incision in acute empyema because they feel that it gives adequate drainage and they hope thereby to prevent osteomyelitis of a rib. That the first contention is correct is proved by many healed cases, but that the second one is not correct has been mentioned above. There are any number of cases to prove the contrary. For the reason that good drainage is more easily maintained if a portion of rib has been resected, I believe the best routine method of operating to-day is costectomy. By gradually reducing the length of drainage tubes, instead of their calibre, no difficulty is experienced in bringing the great majority of all acute empyema cases to a successful conclusion.

2. *Improperly Placed Drainage Opening.*—In discussing this subject we have to consider what is the best routine incision. In a typical empyema case the fluid collects by gravity in the lower thorax. Experience has shown that the costophrenic sinus usually becomes obliterated quite early, so that the floor of the cavity is found opposite the eighth or ninth rib. In these patients therefore resection of a portion of the eighth or ninth rib, or an intercostal incision in the eighth or ninth interspace, just external to the angle of the scapula, will place the drainage at the most dependent part of the cavity. The incision should always be made in such a way that good drainage will result while the patient is in bed on his back. Such an incision will give equally good drainage in the erect position, and that is important, for the aim in empyema is to get the patient out of bed early. The above-mentioned incision is therefore recommended in the typical case. Any variation from this may lead to imperfect drainage. Thus we have found that the drainage opening may be too high, too low, or too far forward. If it is too high, sacculation of pus is the result. In such a patient it will be necessary to change his position at dressing time in order to adequately clean out the cavity. At the next dressing a similar condition is found. In the desire to place the drainage opening at the lowest part of the cavity it is sometimes made too low. If, for instance, the tenth or eleventh rib is resected, imperfect drainage is also likely to result, because in the attempt to obliterate the costophrenic sinus the diaphragm becomes adherent to the chest wall, firmly enclosing the drainage tube. The latter finally will enter the cavity above only through a narrow sinus. As soon as the tube slips out, or is left out, a valve-like action takes place, closing the fistula, allowing damming back of pus, and favoring chronicity (Fig. 7).

A similar condition is apt to occur if the opening is made too far forward in the same rib bed. Valve action will here also develop and lead to imperfect drainage. With any of these improperly placed openings chronicity is of

course more likely to result if the drainage opening is at the same time allowed to contract.

In patients with encapsulated empyema the drainage has to be established wherever pus is found. One sometimes feels very fortunate in finding it at all, after many unsuccessful attempts have been made. The question of drainage at the most dependent part can be taken up later. That it is sometimes very difficult to enter a small cavity is amply demonstrated by a number of cases that came to us. Case No. 28 had been unsuccessfully punctured fourteen times before he came to us, about seven months after his pneumonia, with the diagnosis of unresolved pneumonia.

In very sick patients one may find it at times advisable to establish drainage at a place not representing the dependent part of the cavity. The criticism in these cases is not

that the opening was made, but that no effort was made later to correct the condition. If after several weeks one finds that there is poor drainage on account of an improperly placed opening, the condition should be corrected. One should not allow months to pass and the patient to become a chronic invalid.

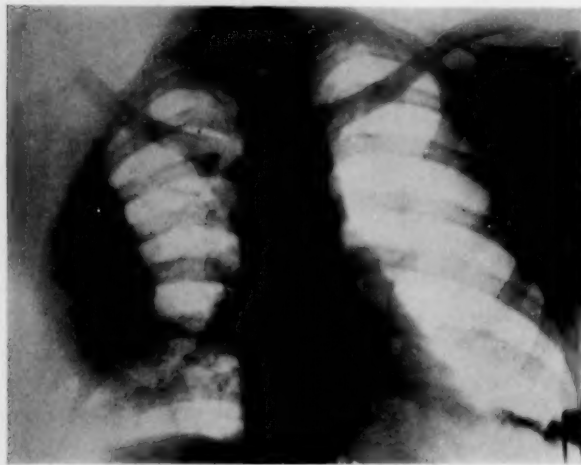


FIG. 7.—Empyema cavity with a narrow fistulous outlet situated very low and responsible for imperfect drainage.

3. *Pockets and Recesses—Separate Cavities.*—These are more

common than is ordinarily believed. Not every empyema represents a smooth-walled globular or flattened cavity. In the attempt to wall off a suppurative fluid within the pleura, adhesions form between the lung and the chest wall, and sometimes divide the cavity into several compartments. In other cases old adhesions may be present from a former pleurisy. When the empyema is drained, the lung will gradually expand. Unless one has been dealing with a smooth cavity, this expansion will be irregular, and in this way small compartments or recesses are shut off from the main cavity. They may continue to communicate with the main cavity by a narrow fistula and for a while drain into it. As the expansion of the lung increases they may become entirely shut off and in this way a separate cavity may develop. Pockets and recesses may be found anywhere near the margin of the cavity, extending upward, to the mediastinum, or downward. The most common ones are found to extend into the costophrenic sinus, either forward or backward, sometimes several inches deep. These recesses represent narrow

CHRONIC EMPYEMA

tortuous sinuses, lined with infected granulation tissue and sometimes contain pus in their distal end. They are responsible for continuation of infection in the main cavity, as well as for recurrences.

If a patient is observed carefully during his convalescence such pocketings of pus may be diagnosed and steps taken to drain them. As long as they communicate with the main cavity they may be recognized by the following:



FIG. 8.—Separate empyema cavity in a patient in whom one cavity is being drained through a resection of the ninth rib, posteriorly. This cavity was later drained by a resection of the seventh rib, more anteriorly.

During irrigation it will be found that after a while the fluid returns clear. If the position of the patient is now changed and pus again flows, or if it flows upon coughing or straining, the existence of a pocket is strongly to be suspected. An X-ray taken after the injection of the cavity with bismuth will usually clear up the diagnosis. If a pocket becomes completely shut off, a little temperature may develop, and the patient may complain of pain and increased dyspnoea. Sometimes these pockets break spontaneously into the main cavity, in other cases they are opened by an exploratory forceps intro-

duced at dressing time. Sometimes, however, an entirely separate cavity exists that has apparently had no communication with the main cavity. In the presence of an open thorax physical signs are misleading, and in such cases the greatest aid in diagnosis is the X-ray. Figure 8 represents such a separate cavity, existing in a patient in whom another cavity is being drained through a resection of the ninth rib. The pocket shown was later drained by resection of a portion of the seventh rib, more anteriorly. This pocket was suspected a few weeks after the original operation, because the return flow from the cavity was clear and still the temperature did not go to normal.

Pockets and recesses are more common in the empyemas following a broncho-pneumonia and of streptococcus origin, than in those typical pneumococcus empyemas following lobar pneumonia.

The use of the X-ray during convalescence is strongly to be recommended. It helps one to localize pockets, to note diminution in the size of the cavity, and it enables one to take steps early to counteract any influences tending to chronicity.

4. *Infected Lining Membrane.*—In patients who have drained a long time, especially in those in whom retention has taken place from time to time, or who have a contracted drainage opening, the abscess wall eventually becomes very thick, varying from one-quarter to three-quarters inch. Establishment of improved drainage, followed by Dakinization, sometimes leads to a cure. In other cases healing fails to result. Investigation led us to look for the cause in the wall itself. On the theory that the abscess wall of an old empyema is similar to that of other suppuration wounds, as for instance osteomyelitis, we had sections made of the parietal pleura. In many instances we found collections of round cells and minute abscesses. Frequently it was possible to demonstrate cocci in these little abscesses. It appears therefore that it is the breaking down of these abscesses that leads to reinfection and recurrence in a certain number of cases.

5. *Rigid Unyielding Cavity.*—Without any other complication, and with good drainage established at the dependent part, a cavity will at times refuse to heal. As long as organisms are present they may be held responsible, but after the cavity has been sterilized and healing still refuses to take place, we have to look for other causes. Nature has done all she can do by drawing in the chest wall, pushing up the diaphragm and pushing or drawing out the lung. The walls are simply so rigid that they cannot approximate. Sometimes closure will take place if a sterile dressing is applied and the cavity sealed without disturbing it. It has been found that the edges may join and that by a gradual absorption of air the cavity will obliterate after several months. This is however an uncommon observation. Sometimes it is impossible to sterilize a cavity, even with the most scrupulous attention to the details of the Carrel-Dakin treatment, and the discharge will continue. These patients have to be subjected to a radical operation.

CHRONIC EMPYEMA

6. *Pneumothorax*.—Any large empyema cavity is apt to be called a pneumothorax. It is my belief, however, that this term should be reserved for a certain type of case, which differs in its development from the usual empyema. The essential difference is that in ordinary chronic empyema we deal with a compressed lung, while in pneumothorax we are dealing with a collapsed lung. The pathological picture of the two conditions differs in various important points, and the mode of formation is different. In ordinary empyema the fluid develops slowly, and as it increases, the lung is gradually compressed, the fluid being surrounded by a wall of adhesions which keep it away from the free pleural cavity. When such an empyema is opened, the lung will not collapse, it may even partly reexpand immediately, because the pressure of the fluid has been removed. Such a cavity is a true empyema cavity. Pneumothorax, on the other hand, is produced in one of

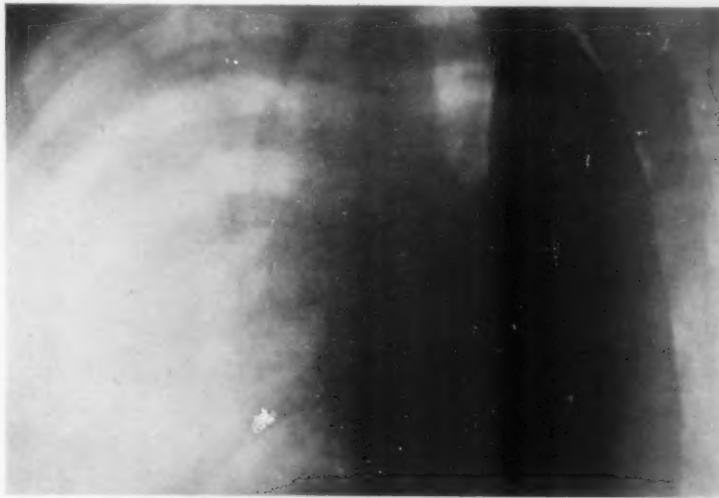


FIG. 9.—Typical chronic pneumothorax filled with bismuth.

two ways, either by the perforation of a lung abscess, leading to pyo-pneumothorax, or by an early operation at a time when no adhesions have formed to hold the lung to the chest wall. In either case the lung collapses and remains in that condition. This is the reason pneumothorax presents so much difficulty in healing.

In chronic empyema, the cavity may be any size or shape, but it will be found that the lung is adherent to the chest wall at the apex, as well as at the sides, so that a portion of it is functioning. In a pneumothorax, on the other hand, we have one large cavity extending from the diaphragm to the apex of the thorax. The lung has completely collapsed towards the mediastinum, and is thrown out of function. In the X-ray the visceral pleura is shown as an almost straight vertical line, and after bismuth injection a long vertical cavity is shown (Fig. 9).

In the entire series here considered there were only eight cases with a pneumothorax. I think the reason we did not have more is because most of the patients who developed an acute pneumothorax died. These cases simply represent the survivors. With the recognition of the importance of acute pneumothorax, and the value of delayed operation, as well as with the improved methods of closed drainage in those patients, in whom early operation is indicated, chronic pneumothorax should come under treatment less often than heretofore.

It is a difficult condition to heal, and because the lung collapses, changes take place in its tissue which do not favor reëxpansion. Unless the condition is recognized early, before fibrous tissue bands extend from the pleura into the lung parenchyma, it is impossible to bring about inflation of the lung. If recognized early, good drainage combined with arm exercises and the use of blow-bottles, may bring about a cure. In late cases radical operation aimed at obliteration of the cavity, is indicated. Some of the most difficult problems in this series were presented by patients with a chronic pneumothorax.

7. *Bronchial Fistula*.—I have considered this subject in a separate paper,[†] to which the reader is referred. As stated therein, large bronchial fistulae are the result of traumatism from without, perforation of a lung abscess, or operative intervention for a lung abscess. Those opening on the skin have to be attacked surgically, and closed. Those opening into the pleural, or rather empyema cavity, will usually close spontaneously. This is especially true of the smaller communications which may be real bronchial openings or simply abrasions of the lung parenchyma. The larger ones may refuse to heal and be responsible for the persistence of a chronic empyema. In such cases a radical operation is indicated, the aim of which is mobilization of the chest wall and the lung. This mobilization brings about the mechanical conditions necessary for healing. Recognition of these bronchial communications usually presents no difficulty.

8. *Foreign Bodies*.—Two types of foreign bodies have to be considered, tubes accidentally lost in the cavity, and foreign bodies introduced from without, usually the result of gunshot injuries. The former are an avoidable cause of chronicity, while the latter are not. In our series we had twelve cases in which at some time in their convalescence a foreign body was found, a rubber tube in five and a bullet or shell fragment in seven.

The question may be raised whether these foreign bodies are the cause of chronicity, or whether they are simply incidental to it. They may be alone responsible for keeping up a discharge and their removal will lead to prompt healing, or they may be removed and the discharge will continue just the same. This is due to the existence of some other cause of chronicity, such as inadequate drainage. Sometimes a foreign body may heal in and later lead to recurrence, or it may become entirely encapsulated.

[†] The Treatment of Bronchial Fistulae by Carl Eggers. *ANNALS OF SURGERY*, September, 1920.

CHRONIC EMPYEMA

To avoid loss of a tube, one should always keep a pin through its outer end, but in spite of this a tube may slip in by the pin cutting through. This has been repeatedly observed. For this reason it is advisable that the same person dress the patient on successive days, so that the loss of a tube may not escape attention. If a tube has been lost, its removal may be simple or quite difficult. It may be possible to grasp it with forceps and extract it. In other cases it may float into view or even out of the wound during irrigation, especially if the cavity is filled while the patient lies on his normal side. Sometimes it is necessary to enlarge the opening to extract it.

The diagnosis can usually be made by means of the X-ray. The better, or rather the purer the rubber, the less apt is it to show on the plate.

In gunshot cases it is not only projectiles that keep up a discharge, but other foreign bodies, as pieces of uniform or leather may be responsible.

9. Tuberculosis.—Typical cases of tuberculous empyema are not to be considered here, but only those cases which have been considered empyema of ordinary origin, and in which on account of chronicity special effort has been made to make a diagnosis. The general condition of these patients is often quite good, but some of them are physical wrecks.

In any patient, in whom a discharge continues for a long time, in spite of good drainage and irrigation treatment, tuberculosis must be considered.

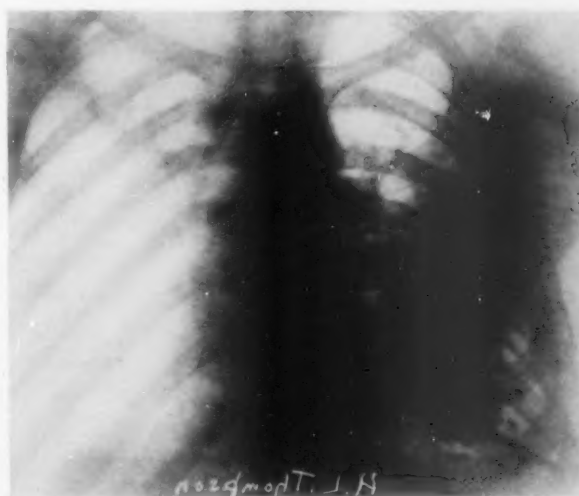


FIG. 10.—Chronic cavities filled with bismuth, showing variation in position, size and shape.

Tubercle bacilli can sometimes be demonstrated in a smear from the discharge. In other cases a guinea-pig injection may be positive. In still others one may make the diagnosis on a section of excised pleura. The patient may have tubercle bacilli in his sputum, and may have been suspicious of pulmonary tuberculosis before he developed empyema, or he may have an old healed apical lesion. Sometimes no intrapulmonary focus can be made out at all, even in the presence of a positive tuberculous pleuritis. The presence of tuberculosis does not preclude the possibility of healing. Even these cases are favorably influenced by Carrel-Dakin treatment, and may heal. In other cases a radical operation may lead to a cure. In still others the general condition is of prime importance. They have to be subjected to a regular course of anti-tuberculous treatment, being content to keep the wound clean. The use of iodoform oil injections in these patients is recommended, combined with sunlight treatment. A tuberculous empyema, recognized as such should not be opened unless secondary infection has developed.

In our series there were two proven and eight suspicious cases of tuberculosis. Of the latter, two have since died of tuberculosis.

10. Dakin Treatment.—Occasionally a case comes under observation in which Carrel-Dakin treatment has been faithfully followed for a long time without having been able to produce healing, even if sterility had been obtained or if the case was clinically sterile. In the absence of other factors that could be held responsible, we have resorted to the simple expedient of removing the tubes and discontinuing all irrigations, and have been gratified to see the empyema obliterate and the wound close in a very short time. A well Dakinized cavity will become dry in a remarkably short time after stopping treatment. In some of these patients it appears that the presence of Carrel tubes acts as an inhibitory agent and prevents expansion of the lung, and the Dakin solution itself acts as an irritant and keeps up the discharge.

11. General Constitutional Condition.—This subject is considered last, not because it is of little importance, but because it plays after all a secondary rôle. As mentioned before, it has been our experience that in practically all chronic empyema cases there is a local condition to account for the chronicity. On the other hand, it is also true that, the local conditions being favorable, and drainage well established, healing will take place more rapidly in those patients in good condition and with no constitutional disease than in those who may have been weakened by the co-existence of other conditions. The aim is therefore to improve the general condition of the patient while drainage is going on. This is best done by the administration of wholesome general diet, with the addition of milk and eggs. Deep breathing exercises, arm exercises and fresh air and sunlight, are all of great importance.

Diagnosis.—A diagnosis of the severity and extent of the condition is necessary for intelligent treatment. First in order is a careful history, especially in regard to the antecedent disease, in order to determine whether the patient is more likely to have had a lobar or a broncho-pneumonia, or whether tuberculosis has to be considered. It is necessary to inquire regarding the

CHRONIC EMPYEMA

presence of cough and the kind and amount of expectoration, for this gives information as to the likelihood of an associated lung abscess. Whether Dakin solution is well borne or not, as in cases with bronchial communication, has to be determined. This is followed by a physical examination and cultural examination of the discharge. The thoracic fistula is carefully examined, whether it is superficial or deep, whether it has contracted, whether it leads to rough bone. The cavity is then measured and an attempt is made to determine whether retention and pocketing exist. An X-ray of the chest is taken for general orientation and the possibility of the presence of a foreign body. For accurate understanding such an X-ray is usually unsatisfactory, but it shows whether there is thickened pleura, or a secondary pocket, or fusion of ribs, or sometimes osteomyelitis. The most important aid in the diagnosis is obtained by injecting the sinus or cavity with an opaque fluid and then taking a stereoscopic X-ray. If it is possible to insert a catheter, it is passed to the apex of the cavity and the opaque solution injected, otherwise a blunt-nosed glass syringe is put into the sinus opening and the injection

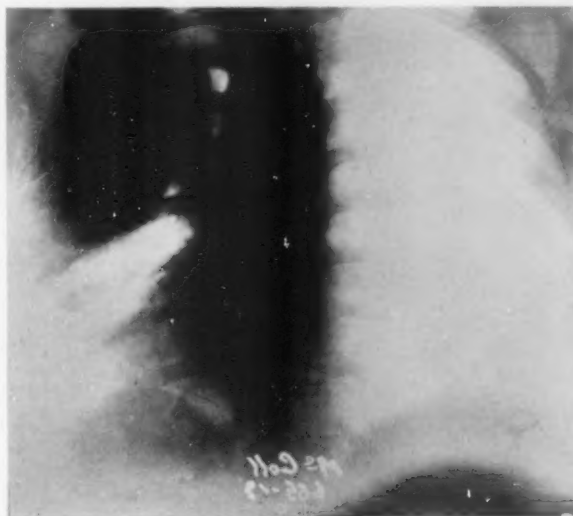


FIG. 11.—Chronic empyema of posterior chest, draining through an anterior fistula. Diagnosis made by bismuth injection.

done in that way. We use for this purpose a suspension of bismuth subnitrate 20 per cent. in cottonseed oil, and add to this 3 per cent. acacia. This oil is easily injected, gives an excellent picture, and has the additional advantage that it will flow out readily after the pictures have been taken. Excellent outlines of cavities and sinuses with their ramifications are obtained in this way (Figs. 10 and 11). After the cavity has been emptied by the patient straining, another picture is taken. This gives valuable information, for in this way one can see whether there is bismuth retention in narrow recesses or pockets.

We have seen no untoward effects from the injection of this bismuth emulsion. No symptoms of poisoning have been encountered. The precaution should be observed to inject slowly and without too much force, interrupting from time to time to allow air bubbles to escape.

Complications.—Most of the so-called complications of chronic empyema are really complications that developed during the acute stage and are carried over into the chronic stage.

The most common one is anæmia, ranging from mild affections to very severe secondary anæmia. It is due to sepsis, especially streptococcus sepsis. Free drainage of the empyema cavity, Carrel-Dakin treatment, plenty of nourishing food, medicines, fresh air and light exercise out of doors help to restore the blood condition to normal. Among the real complications endocarditis, myocarditis, and multiple arthritis are the most important. The heart of some of these patients is very rapid, accompanied by dyspnoea on slight exertion, which is not accounted for by the throwing out of function of the lung on the affected side. Displacements of the heart with fixation in abnormal positions may be responsible. In most patients the heart condition recovers, while a few remain chronic invalids. In our entire series there were four cases with a real endocarditis. Joint involvements are also not common. Transitory joint pains are frequently encountered, especially in patients with a contracted drainage opening, and in recurrences. Pain in the joints is sometimes the first symptom patients with a recurrence complain of. It is no doubt due to absorption of toxic material. Severe joint involvement was encountered in only four cases, and in two of these it was due to the use of Dakin solution.

Lung abscess is really the primary disease in some cases of empyema, and should therefore not be considered here as a complication.

Bronchial fistulæ have been mentioned above.

One of our cases developed an acute streptococcus septicæmia after he had been healed for a few weeks. Although he looked like a hopeless case, he recovered after the administration of large doses of anti-streptococcus serum and three blood transfusions from a patient who had recovered from a streptococcus empyema.

Treatment.—Treatment directed towards improving the general condition is carried out coincident with attention to the local condition.

The patients are put on a liberal mixed diet, and milk and eggs are given between meals. They are kept out of doors whenever the weather permits. Deep breathing is encouraged and lung expansion with the aid of blow-bottles is practiced. Light arm exercises are begun early, and as soon as the general condition of the patient permits regular setting up exercises are carried out and gradually increased. These exercises aid expansion of the lung, they bring about better oxygenation of the blood and better emptying of the cavity. The patients with chronic empyema are often depressed and discouraged, and it is necessary to instil a more hopeful attitude. This can be brought about by having them associate with patients similarly afflicted, but nearer a cure.

The local treatment has to depend on the conditions found on admission. Superficial sinuses and their treatment have been discussed above. We are here concerned with deep sinuses and with cavities. Regardless of the underlying condition we have put these patients on Carrel-Dakin treatment with the idea of improving the condition of their wound and to clear up sepsis. The great majority of the patients have insufficient drainage when they come under observation, either due to a contracted drainage opening, or to an

CHRONIC EMPYEMA

improperly placed drainage opening. The first concern therefore is to give them an opening sufficiently large to allow the introduction of antiseptic solutions and to assure free exit. This is done in various ways either by the gradual dilatation of the existing opening, or by an operative enlargement of the opening or by the establishment of a new opening at the dependent part of the cavity. The simplest way is tried first, either by choice, or because the patient objects to anything requiring a knife. In many patients it is possible to bring about gradual dilatation of the drainage canal with the aid of a stiff catheter or bougie. This catheter is allowed to remain in place 24 hours and the following day a larger one is introduced. By these means one can often get enough dilatation to admit one or two Dakin tubes and an outlet tube. Regular Carrel-Dakin treatment is now started, using an amount somewhat less than the capacity of the cavity. Quite a number of cases are cured in this way.

If a bony ring has formed around the sinus opening, making dilatation impossible, it is best to operate. Short pieces of one or two ribs are resected under local anæsthesia and the entire fistula dissected out. Several Dakin tubes and an outlet tube are inserted and the treatment started at once. It is surprising how quickly many of these patients will clear up after good drainage is established and the old infected sinus tract removed.

If it is found that sacculation of pus takes place, due to a drainage opening placed too high, a new incision is made at the dependent part of the cavity. The site of this new incision is determined upon after thorough study of the case with the aid of a probe or an X-ray after bismuth injection, or both. At the time of operation the old sinus is curetted and is then allowed to close.

In patients who resist this treatment other causes have to be looked for. A foreign body may be present which, if accessible, must be removed, and conservative treatment then continued. In case a lobulated cavity is present or a separate cavity, a counter-incision may clear up the condition. The majority of chronic empyema patients are cured by the simple methods just described, but a certain number refuse to heal. Drainage and superficial sterilization of the cavity alone, or combined with attention to the general condition of the patient are not sufficient. In these patients certain factors are responsible which do not yield to simple measures, and radical operation has to be resorted to. One may be dealing with a lung which has become so fixed in its position, that it is unable to expand, the lining of the cavity may be infected in its deeper layers and lead to reinfection, there may be recesses or pockets, we may be dealing with a collapsed lung, or with tuberculosis, or there may be a foreign body which is inaccessible, or there may be one or more broncho-pleural fistulæ. The treatment of all these conditions will be considered in a separate paper, to be published shortly.

Carrel-Dakin Treatment.—Though this method of treating suppurative wounds has been used now for a number of years, there is still no unanimity of opinion as to its value or usefulness. Some surgeons consider its introduction one of the greatest medical achievements of the war, while others are very emphatic in its condemnation. I was never swept away by the wave of enthusiasm that passed through the surgical world in 1917 and 1918, when

extraordinary claims as to its efficacy were made. In order to test the merits of Dakin solution, I used it extensively during the war in ordinary suppurative wounds as well as in empyema. In a paper on a series of acute empyema cases reported in 1919 ‡ I ventured to say that comparisons between cases treated with Dakin's or other antiseptic solutions and those with simple drainage failed to show any superiority in favor of Dakin solution. Nevertheless, I used it exclusively in another unpublished series of acute empyema cases and became convinced that by these means we were unable to materially shorten the course of the disease. The solution has, however, certain advantages. It keeps the wound clean, it does away with foul-smelling, disagreeable pus, and thereby prevents absorption of septic material. I believe in using it in acute empyema early in the disease only for one daily irrigation, and later, when the acute inflammatory reaction of the pleura has subsided, in the regulation manner. Even then I do not favor its continuous use, but rather prefer to use it at intervals for a few days only and alternate with several days of simple drainage. The burning and annoyance patients at times complain of are thus avoided, and during the periods of simple drainage blow-bottles may be used to advantage.

In chronic empyema, on the other hand, I believe Dakin solution to be of really great value. No one, who has seen a large series of cases cleared up by the scientific application of the Carrel-Dakin method can fail to be impressed. Of our 192 patients, 173 had received Carrel-Dakin treatment at some time during their convalescence before they came to us, given more or less according to regulations, and 19 had been treated by simple drainage. At our hospital all were put on intensive Dakin treatment as soon as proper drainage had been established. The solution was injected every two hours during the day and every four hours at night. The amount was slightly less than the capacity of the cavity. The wound was cultured once a week, and as soon as a sterile culture was obtained, the test was repeated every day without change in treatment. After seven consecutive cultures had been reported negative all treatment was discontinued and the wound sealed and left undisturbed for a week. At the end of that time it had usually closed or nearly so and simple sterile dressings were reapplied.

Disadvantages of This Treatment.—1. The patients are always wet, which is at times very annoying to them. We have tried to overcome this by having an inner and an outer dressing. The inner one consists of several layers of gauze surrounding the tubes, and is held in place by adhesive plaster strips to which tape is attached. This dressing is not disturbed during the day. The outer dressing consists of large pads reaching well down to the lumbar region, and is held in place by a binder. These pads may be changed by the nurse any time during the day or night.

2. The skin often becomes irritated. Some patients are so susceptible that they easily develop an eczema. The treatment is preventive. As a first

‡ Empyema. Analysis of 70 Cases at Base Hospital, Camp Jackson. Carl Eggers, New York.

CHRONIC EMPYEMA

requisite one should make sure that the solution is properly made. The skin should be protected with vaseline strips, smoothed out onto the skin so that no solution can get under it. These strips should run up to the wound edge, but not onto the granulations. Once an eczema is established, the use of the solution should be discontinued for a few days and drying ointments used in the meantime. Another important point is to clean the skin with alcohol at each dressing and to dry it before applying the vaseline strips.

3. Burning in the wound is usually complained of only by patients with acute empyema. It is due to the irritant action of the solution on the acutely inflamed pleura and on the cut surfaces of the soft parts of the chest wall. It is best avoided by using it as indicated above. Occasionally patients with chronic empyema complain so much that it is wise to discontinue its use for a few days or permanently.

4. Nausea, vomiting or diarrhoea are at times encountered, and do not yield until Dakin solution is discontinued. Nausea alone is quite common and is experienced by some patients at every injection of the solution, while actual vomiting or diarrhoea are encountered infrequently.

5. Arthritis was found to be due to the use of Dakin solution in two cases. The demonstrations were so decided that there was no doubt about the relationship. The arthritis in both cases was multiple in type, accompanied by swelling and redness. The pain was excruciating. It began to subside a few hours after discontinuing treatment. Repeated tests were made on both these susceptible patients. While they were entirely normal, Dakin solution was again used and in a few hours the pain and swelling in the joints became so severe that it had to be discontinued. Whether it is due to the action of the solution itself, or whether the solution liberates toxins in the empyema cavity which, when absorbed, cause the symptoms, could not be determined.

6. It seems that occasionally Dakin solution may be responsible for continuation of temperature. We had one patient, a bilateral empyema, in whom this was very noticeable. Careful examination had failed to reveal any complication, there was no pocketing, but the temperature went to 102 or 103 every evening. Discontinuing Dakin solution brought the temperature to normal in two days and it remained that way. A subsequent test again brought a rise of temperature, which again promptly subsided when the solution was stopped.

Results Obtained.—Of the 192 patients under our care 12 had a superficial fistula and were treated by complete excision of the tract with surrounding diseased skin, bone and pleura as described above.

All the other 180 patients were treated by the Carrel-Dakin method. This treatment was continued as long as there was reason to believe it would lead to healing. Of this number 62 showed no tendency to heal or conditions were recognized that interfered with healing. These patients were therefore subjected to a radical operation and are included in a paper on the radical operation for chronic empyema to be published shortly.

CARL EGGERS

Of the remaining 118 patients, 104 healed in an average of 116 days from the last operation, and 14 were transferred unhealed. In these unhealed patients the chances for healing were good, they simply required more time, and they were therefore not operated upon.

In the four months' period I was in charge of General Hospital No. 12, from the end of April, 1919, until the end of August, 1919, when the hospital was closed,

- 141 cases were discharged healed.
- 45 cases were transferred to other hospitals.
- 4 cases were discharged unhealed at their own request.
- 2 cases died after a radical operation.

The healed cases were made up as follows:

After excision of superficial fistula	11
After Carrel-Dakin treatment	104
After radical operation	26
	—
	141

The group of cases transferred to other hospitals was made up as follows:

Unhealed, and still on Carrel-Dakin treatment	14
Unhealed after excision of superficial fistula	1
Unhealed after a radical operation	27
Healed, but transferred on account of complication	3
	—
	45

The patients of this group who were unhealed after a radical operation were convalescing. Some had been operated upon but shortly before they were transferred; they simply required more time. It is known that of these unhealed transferred patients,

- 19 healed soon after transfer.
 - 9 remained unhealed.
 - 2 died later of tuberculosis.
 - 12 have not been heard from.
-
- 42

At the time of discharge we made observations on the physical condition of all patients and noted their chief complaint.

Weight is an important index of the patient's condition, and we utilized it in determining whether a patient was fit for discharge. It is an interesting fact that many empyema patients put on weight, considerably beyond their normal, while they are convalescing. At the time of discharge:

- 45 had their normal weight.
 - 40 were overweight.
 - 22 showed extreme overweight, 15 lbs. +.
 - 19 were up to 5 lbs. underweight.
 - 15 were up to 10 lbs. underweight.
-

141

CHRONIC EMPYEMA

Dyspnœa in some degree was found present in the majority of cases. However, this applied chiefly to walking out of doors in rolling country. To the question: "Do you get short of breath?"

40 answered "no."
82 had slight dyspnœa.
3 marked dyspnœa.

141

Chest measurements were made with an ordinary tape measure, from the median line in front to the median line behind, at a level just below the nipples in front and below the angle of the scapula behind, with the chest at rest.

55 cases showed no difference between the two sides.
43 cases measured 1 inch less on the affected side.
34 cases measured 2 inch. less on the affected side.
9 cases measured 3 inch. less on the affected side.

141

Expansion was rated by simple observation only, both from the front and from behind. It was found to be good in 87 patients.
restricted in 47 patients.
poor in 7 patients.

141

Deformities of 141 patients examined 66 showed no deformity.
57 showed slight flattening of the chest.
23 showed marked flattening of the chest,
30 showed various degrees of curvature
of the spine.
11 had shoulder elevation on the affected
side.
14 had shoulder elevation on the normal
side.

Flattening of the chest is not in all cases due to collapse of the chest wall. In many instances, especially in those less marked, it is due to atrophy of the pectoral muscles caused by non-use of the arm. Exercise will restore many of these to normal. When due to actual collapse of the chest wall, which represents one of nature's efforts to obliterate the empyema cavity, the deformity is permanent.

Curvatures of the spine also frequently respond to exercise, but if they have persisted for a long time, they may be permanent. Attention has been called to the importance of not allowing empyema patients to remain long in bed in a cramped position, but to get them out early and to encourage the use of their muscles. Some of the spinal curvatures are improved by radical operation which does away with the fixation of the chest caused by fusion of ribs and thickened contracted pleura.

CARL EGGERS

Shoulder elevations are acquired postural deformities. The treatment is chiefly preventive. It must begin in the acute stage of empyema. Owing to pain or cumbersome dressings patients with empyema are inclined to assume different abnormal postures. Correcting positions early and encouraging patients to use their muscles and breathe deeply, especially while standing in front of a mirror so that they may observe themselves, are important factors in preventing permanent deformities.

All these observations were made on healed patients, in some about two months after closure of their wound, in others only two weeks after healing. Many of the lesser degrees of deformity will improve as time goes on, but it is nevertheless true that a large number of patients healed after having had chronic empyema for a long time are permanently damaged. They are usually able to follow their former vocation, but aside from varying degrees of deformity they have less endurance, they are apt to become dyspnoeic and they frequently have pain in the affected side. It should therefore be the aim of every surgeon treating acute empyema patients to prevent them passing into the chronic stage. Restitution to normal usually takes place if drainage has not been continued too long.

My sincere thanks are due the different surgeons and nurses of General Hospital No. 12 for their excellent spirit of coöperation, their devotion to duty and their attention to the details of the Carrel-Dakin technic, which made the described results possible. I want to especially thank Miss Elise Kudlich, not alone for her aid as an expert technician in the use of the Carrel-Dakin method, nor for her help in collecting information about patients, but for her sympathetic, cheerful and helpful attitude to the unfortunate and discouraged empyema patients who came under her care.

INGUINAL HERNIA IN THE MALE

LATE RESULTS IN 978 TRACED CASES

BY SEWARD ERDMAN, M.D.

OF NEW YORK

FROM THE SECOND SURGICAL DIVISION OF THE NEW YORK HOSPITAL

IN the five-year period from January 1, 1915, to January 1, 1920, there were performed 1093 elective operations for inguinal hernia in the male, on the Second Surgical Division of the New York Hospital, under the direction of Dr. E. H. Pool.

To date there are 73 known recurrences, or 6.67 per cent. In addition there were 32 emergency operations for strangulated inguinal hernia in the male, which are not included in this report (as they will be published at a later date).

Of the 1093 elective operations, we have succeeded in adequately tracing 978 cases, or 89.5 per cent., and it is our intent to base the analysis of "late results," solely upon the 978 traced cases.

By adequately "traced," we mean that 908 cases have returned to the hospital for careful examinations by different members of the attending staff, not by the operator alone. We have included 70 cases reported by letters from physicians who had examined the individual, or letters announcing the acceptance for service in army or navy, or letters stating that a second operation for the hernia had been performed. Letters based solely upon the patient's own impressions have not been accepted by us as convincing.

Thus of the 978 traced cases, 92.84 per cent. have returned for examination, and 7.16 per cent. were traced by letter.

The follow-up system of the Second Surgical Division calls for examination of the patient on at least three occasions, respectively, at three months, at one year, and at two years after the hernia operation.

An analysis of the series here presented shows that the return visits actually averaged more than 2.5 for each patient, over periods ranging from the minimum of three months up to seven years.

Certain cases of doubtful prognosis or unusual interest have been reexamined as many as eight and ten times.

The operators in this series were nineteen surgeons, a large proportion being house surgeons but always under the immediate direction of a member of the attending staff of the division.

The known recurrences among 978 traced cases number 73, or 7.46 per cent.

We believe that actual examination of the patient at intervals after the hernia operation provides the only reliable criterion for estimating the number of recurrences.

SEWARD ERDMAN

The application of this standard will inevitably show a higher percentage of recurrences, but there can be no advantage in any evasion of the facts.

One occasionally reads a report of a series of cases by one individual

TABLE I.

	Operations	Recurred	Percentage
Oblique.....	665	21	3.15%
Direct *.....	313	52	16.61%
Total.....	978	73	7.46%

*In Table I, we have included under the term "direct", that mixed type often called "saddle-bag" or "direct-indirect", because we believe that in these cases it is the "direct" weakness which constitutes the surgical problem in repair and for other reasons of similarity which are to be mentioned.

surgeon, in which the results claimed are nearly perfect, but this must be regarded as unproven, unless a complete follow-up is used.

Certainly the records of the average surgeon and of the best hospitals will show a not negligible recurrence rate.

It is only with the recent introduction of adequate follow-up systems that anything approaching accuracy of statistics has become possible.

One of the most valuable and illuminating reports in recent literature on hernia was contributed by A. S. Taylor to the *Archives of Surgery*, Septem-

TABLE II.
Recurrences in Direct Hernia.

	Operations	Recurred	Percentage
Direct (simple)...	256	44	17.1%
Direct-indirect...	57	8	14.0%
Total.....	313	52	16.61%

ber, 1920, vol. i, pp. 382-406, entitled "The Results of Operation for Inguinal Hernia; Performed in the Johns Hopkins Hospital from January 1, 1899, to January 1, 1918."

Among 816 oblique herniæ, traced, there were 5.6 per cent. known recurrences; and in 94 traced direct herniæ the recurrences were 18.08 per cent.—Of the 94 direct herniæ, 47 were examined at the Johns Hopkins Hospital and showed 14 recurrences or 29.7 per cent.—The remaining 47 direct herniæ reported by letter only, adding 3 recurrences, but reducing the percentage for the 94 direct cases.—In the entire Johns Hopkins series slightly less than half were examined, the remainder reporting by letter.

At the New York Hospital we have found that a degree of care must be exercised in the examination of the returned patients in confirming the diagnosis of recurrence.

INGUINAL HERNIA IN THE MALE

Allowance must be made for a slight degree of bulging and impulse along the structures of the cord, especially in those cases of direct hernia where the cord structures may have been transplanted outside of the aponeurosis.

Case 840, New York Hospital, was adjudged a recurrence by reason of such a bulge and impulse although no sac could be made out. This case was submitted to a second operation at which time a very careful search failed to reveal any type of hernia.

Five other cases which were recorded for a time as either "actual" or "doubtful" recurrences were later stricken from that classification after conscientious deliberation by the attending staff. These five cases were subjected to the closest scrutiny and to repeated examinations over periods ranging from two to five years, but failed to develop evidence of a sac and remained free from symptoms, although no truss was worn; in fact, there never was more than the slight bulge and impulse over the transplanted cord.

TABLE III.
Time of Recurrence Following Operation in 978 Traced Cases.

	Operations	Total recurred	Recurrence first noted				Total within 2 yrs.
			within 6 mo.	between 6-12 mo.	between 12-18 mo.	between 18-24 mo.	
Oblique.....	665	21	10	6	2	2	20 or 95.2%
Direct.....	313	52	25	13	10	4	52 or 100.0%
Total.....	978	73	35	19	12	6	72 or 98.6%

This table shows that 47.9 per cent. of all recurrences were noted within six months after operation; 73.9 per cent. within 12 months; 90.4 per cent. within 18 months and 98.6 per cent. within two years.

It is essential that examinations should be made at intervals during the first two years in order to properly estimate the time of recurrence.

If a patient is not seen until several years after operation, it will be impossible to decide when the recurrence first developed.

We may state as a general proposition that a hernia which has not recurred within two years after operation is cured.

It appears to the writer that the small number of exceptions to this rule should not be considered as operative failures but occur as the effect of advancing years, weakening of the abdominal muscles, a fresh trauma, or other factors which are quite as likely to produce a hernia upon the non-operated side as at the site of operation.

Several causes for early recurrence become evident in the series studied; thus

(A) Direct sac overlooked at operation.

In five instances the operator stated that no sac was found, nevertheless within three months a definite hernia was present.

All five failures occurred in cases diagnosed as bilateral direct herniæ, and our experience would indicate that in such doubtful cases the peritoneum should be opened and the slack taken up, even if no definite sac be recognized.

(B) Cases of incomplete repair by reason of the physical condition of the patient on the operating table.

(C) Post-operative accident.

Case 770, aged seventy years, and alcoholic, developed delirium after an operation under local anaesthesia, jumped out of bed on the day after operation and presented a definite recurrence at the first examination, three months later.



FIG. 1.—Typical bilateral direct hernia. Note the egg-shaped swellings opposite external rings. Direct sacs seldom enter the scrotum.

The average age at operation was 38.0 years for the direct herniæ and 38.5 years for the "direct-indirect."

For the oblique herniæ, the age average was 27.8 years.

The wards of the New York Hospital accommodate both children and adults of the two sexes.

The hospital is centrally situated and draws upon a mixed population, including many foreign born, especially Italians and Russian Jews; its service represents a fairly typical cross-section of the population of New York City.

Although the age at which patients present themselves for operation does not necessarily represent the age at which the hernia originated, nevertheless certain inferences may be drawn from the operative age.

Very few individuals will come to the surgeon at the earliest subjective symptom of a hernia; the majority have been aware of the condition for months or years before seeking relief.

Recently we operated upon a man aged sixty-three years, for a typical congenital hernia, of which he had been conscious for more than 30 years.

GENERAL STATISTICS

During the five-year period, there were performed, including females, 1154 operations for inguinal hernia.

Sex.—Inguinal hernia in the male totaled 1093 cases, or 94.7 per cent. Inguinal hernia in females numbered 61 cases, or 5.3 per cent.

Age.—The youngest patient was six months of age, an infant with a large irreducible scrotal hernia; the oldest was a man of seventy years; both had oblique herniæ.

Children under the age of ten years presented 70 cases, forming only 6.0 per cent. of the series.

INGUINAL HERNIA IN THE MALE

The routine examination of applicants for insurance, or for civil or military service, brings to light many small herniæ never suspected by the applicant.

The writer inclines towards the hypothesis that nearly all oblique herniæ occur into a potential sac, which sac has been present from birth owing to imperfect closure of the peritoneal funicular process.

However, the mere presence of an open peritoneal process does not constitute a hernia until there occurs invasion of the sac by an abdominal viscus.

In our series the operative age for oblique hernia was 27.8 years.

It would appear, therefore, that even in the presence of a potential hernial sac of congenital origin, the actual development of an oblique hernia in the majority of cases occurs in the third decade.

The years of greatest physical exertion, combining muscle strain and exposure to trauma, serve to force abdominal contents into the peritoneal sac and create a veritable hernia, or by enlarging an incipient hernia render it for the first time obvious to the individual.

A difference of over 10 years between the average operative age for oblique hernia and that for the two forms of direct hernia is significant.

The congenital origin of the sac of oblique herniæ, the recognition of

TABLE IV.
Age at Operation.

	Individuals	Average	Youngest	Oldest	Over 50 yrs.	Over 60 yrs.
Oblique.....	694	27.8 yrs.	6 mo.	70 yrs.	61 cases	9 cases
Direct.....	193	38.0 yrs.	20 yrs.	65 yrs.	28 cases	3 cases
Direct-indirect...	52	38.5 yrs.	20 yrs.	65 yrs.	7 cases	1 case

definite hernia at birth or in early childhood, or its development in early manhood, leads to an earlier average age at operation than is the case with the two types of direct hernia.

The earliest definitely direct sac was found in a patient aged twenty years and the average operative age was thirty-eight years.

Hence we conclude that direct herniæ are not due to developmental defect but are acquired later in life.

In our service we have in general followed the rule adopted by the late Dr. W. T. Bull, that herniotomy should be avoided after the age of fifty-five years, unless there are strong indications, such as inefficiency of a truss, inability to wear a truss, strangulation of the hernia, etc.

Among patients over fifty years of age there were performed 70 operations for oblique hernia, showing 2.85 per cent. recurrence.

In the same group there were 49 operations for direct herniæ with 24.4 per cent. recurrence.

SEWARD ERDMAN

In patients over sixty years of age there were 10 operations for oblique hernia with 10 per cent. recurrence; also 7 operations for direct hernia with 42.8 per cent. recurrence.

MORTALITY

In the series here reported there were 938 individuals operated upon for inguinal hernia, with three deaths, or 0.32 per cent.

The three deaths were the following:

1. CASE 442. C—a man aged forty-seven, of poor physique and arrested pulmonary tuberculosis was operated upon for bilateral direct hernia. Pneumonia developed after operation and he died on the 21st day. Cause of death; pneumonia.

2. CASE 524. M—an Italian laborer aged forty-five years and apparently in excellent condition, died on the 11th day after operation.

The convalescence had been smooth and he was allowed to sit up on the 11th day, when he collapsed and died within a few minutes.



FIGS. 2, 3 and 4.—Illustrating the abnormal "muscle bulge" in the inguinal regions.

The operation had been a Bassini operation for direct hernia (right) with ligation and division of the deep epigastric vessels.

Autopsy revealed a thrombus extending down the epigastric vein to the right femoral vein and that death was due to pulmonary embolism.

3. CASE 567. S—aged fifty-six years, of markedly alcoholic habit and poor physique, had been refused operation by us and discharged from the hospital, but soon returned and insisted on undergoing operation. The operation was for bilateral inguinal hernia. Following operation he developed delirium tremens, tore off his dressings and wound infection set in.

Then ensued a severe, spreading erysipelas which terminated fatally on the 16th post-operative day. Cause of death; wound infection, erysipelas.

NON-OPERATED CASES

Fifty individuals entered the hospital with the diagnosis of inguinal hernia, but were not operated upon for one of the following reasons: Fifteen changed their minds after admission and refused operation; 35 others were denied operation after careful physical examination.

INGUINAL HERNIA IN THE MALE

Among the latter, 8 were well over sixty years of age, and 3 were less than one year old; the remainder were considered poor operative risks by reason of pulmonary, cardiac or renal conditions, diabetes, alcoholism, etc.

FREQUENCY OF BILATERAL INGUINAL HERNIA

In our series, 222 individuals were operated upon by us for bilateral inguinal hernia, in the group of 849 males; in other words, one in four individuals were operated for bilateral hernia.

Adding those individuals whose history or whose follow-up examinations proved that sooner or later they had bilateral herniæ, we find that 37.4 per cent. of the 849 males eventually had bilateral herniæ.

Our records show a remarkable difference between oblique and direct types of hernia as regards the incidence of bilateral conditions; thus,

Oblique hernia was bilateral in 26 per cent. of the individuals.

Direct hernia was bilateral in 69.5 per cent.

"Direct-indirect" hernia was bilateral in 63.4 per cent.

As just stated, the incidence of bilateral hernia in the entire series of 849 individuals was 37.4 per cent.



FIG. 5.—Illustrating the bilateral "muscle bulge" shown in standing posture.

ANATOMICAL OBSERVATIONS

A. Oblique Inguinal Hernia.—This type constituted 68.4 per cent. in 1093 operations under consideration.

The oblique sac arises at the internal abdominal ring, being placed between the vas (to its mesial side) and the spermatic vessels (to its outer side) and on a level slightly above these structures.

The sac is often so intimately incorporated with the cord elements because of its inclusion, with them, inside the fascia propria of the cord (i.e., the infundibuliform fascia), that a careful dissection is requisite.

The oblique sac is elongated or funnel-shaped, following the obliquity of the inguinal canal.

Especially in young subjects, it frequently shows constrictions which encroach on the lumen, forming partial or complete partitions between compartments of the sac.

Regarding certain types described in Gray's Anatomy as the "infantile hernia," we have considered this merely as a form of funicular process

hernia; the type described by Gray as "encysted hernia" we have never been able to recognize.

Treatment.—High ligation of the oblique sac constitutes the most important step in the operation for cure, and must be attained in every case.

Our practice is to perform the Bassini operation in nearly all cases over twenty years of age.

Under that age, and especially in young children, we often do not transplant the cord after the Bassini method, but rather employ the non-transplantation method of Ferguson, in which the conjoined muscles are sutured to Poupart's ligament in front of the cord.

This latter method seems satisfactory in young individuals whose musculature is good and the hernia small; also it prevents undue elevation of the testicle in the scrotum, which may occur in young children after the Bassini transplantation of the cord.

The true "congenital" sac, communicating with the tunica vaginalis, is best treated by excision of all redundant parts of the sac and turning back of the tunica with suture behind the testis, thus avoiding danger of hydrocele formation which often occurs when a tunica has been reconstructed.

B. *Direct Hernia.*—This type made up 25.8 per cent. of our series, and was shown to be bilateral in 69.5 per cent. of the individuals.

The neck of the sac arises in Hesselbach's triangle, *i.e.*, mesial to the deep epigastric vessels and lateral to the border of the rectus muscle.

The obliterated hypogastric artery subdivides the space into smaller triangles.

In our experience the direct sac usually arises mesial to the obliterated hypogastric, close to the outer border of the rectus.

Frequently, however, the fibrous cord, representing the obliterated artery, is seen coursing upwards over the dome of the direct sac and causing the sac to bulge forwards on both sides of the artery.

According to the anatomists, Gray and Quain, the "conjoined tendon" is stretched across the inner two-thirds of Hesselbach's triangle, passing inwards and downwards to be inserted into the pubic crest and inner part of the iliopectineal line, immediately behind the external abdominal ring, serving to protect what would otherwise be a weak point in the abdominal wall.

Surgically, no such tendon is recognizable in most cases of direct hernia, and the sac seems to present itself below the lowest fibres of the conjoined muscles.

In any event, the surgeon deals with the muscle bellies of the conjoined muscles and not with any thinned-out, problematical "conjoined tendon" when he sutures the muscles to Poupart's ligament.

We believe that the transversalis fascia forms the first and usually recognizable defense of Hesselbach's triangle and that the adequate repair of a direct hernia should include, whenever possible, the separate suture of this thin but important fascia, chiefly because it offers a smooth inner wall to prevent peritonial fat from insinuating itself between overlying layers.

INGUINAL HERNIA IN THE MALE

The direct sac often emerges through a definite split in the fascia or else stretches and bulges the fascia before it.

Treatment.—Any operation which fails to provide firm and deep closure of the weak triangle of Hesselbach is not a logical operation for direct hernia.

We believe that the cord should always be transplanted and we do not accept non-transplantation operations as suited to the treatment of direct hernia.

C. *Direct-indirect Hernia* ("Saddle-bag Hernia").—In our traced cases there were 57 operations for this type, composing 5.8 per cent. of the total traced hernia operations.

Anatomically, such herniæ possess a sac which bulges on both sides of the deep epigastric vessels.

Usually the direct bulge forms the larger part of the sac, the oblique bulge being smaller and apparently due to the lateral extension of an originally direct hernial sac.

Rarely there is a typical oblique sac associated with a direct hernia on the same side.

The anatomical weakness which is responsible for this type of sac is so often present on both sides, that we found 63.4 per cent. were bilateral.

In the bilateral group, the sacs were of the same "saddle-bag" type on both sides in more than half of the series; in the remainder there was found a direct sac on the side opposite to the direct-indirect sac.

Both surgically and anatomically the "saddle-bag" hernia must be considered and treated as if it were merely a variation of the direct hernia rather than of the oblique, which conclusion we draw from our experience and for the following reasons:

(a) The age at operation, 38.5 years, is practically the same as the age for direct hernia.

(b) Nearly two-thirds of the herniæ of this type were bilateral, which was also true of the direct herniæ.

(c) When bilateral but of different types on the two sides, we found almost without exception a direct sac on the side opposite to the "saddle-bag" hernia.

(d) The percentage of recurrences was 14 per cent., while that for direct hernia was 17.1 per cent.; whereas that for oblique hernia was only 3.15 per cent.

(e) The problem of muscle repair, namely the firm closure of Hesselbach's triangle, is identical with the problem presented by direct hernia.

Treatment.—The direct-indirect sac must be converted into one sac either by pushing to one side (usually laterally) the deep epigastric vessels, or occasionally by ligation and division of those vessels.

The repair of the posterior wall of the inguinal canal should proceed as for direct hernia, and the cord should always be transplanted.

SEWARD ERDMAN

MIXED TYPES OF INGUINAL HERNIA

In general when inguinal herniæ are bilateral, they will be found of the same type on the two sides.

In our series of 222 individuals with bilateral hernia at operation, 203 were found to have identical types on the two sides.

There were sixteen instances of a direct hernia on one side, associated with a "saddle-bag" hernia on the other side, but we have shown that the direct-indirect hernia is in most cases merely a variety of the direct type.

In only three instances in the series, or 1.35 per cent., was there a definite oblique sac associated with either a direct or a "saddle-bag" sac on the opposite side.

ASSOCIATED FEMORAL HERNIA

Although relatively infrequent in the male, the possible association of a femoral hernia with an inguinal hernia must be considered in diagnosis and treatment.

There were two cases of a femoral hernia on one side associated with an oblique inguinal hernia on the opposite side.

Also there were three cases of a femoral combined with a direct hernia on the same or on the opposite side.

Among women (55 individuals with inguinal hernia) we encountered four femoral herniæ, or 7.3 per cent., associated with the inguinal hernia.

SIGNIFICANCE OF WEAK ABDOMINAL MUSCLES

During this study of hernia, Dr. E. H. Pool called attention to the frequency with which we noted a marked bulging of the flat abdominal muscles in the inguinal regions, and we have termed it the "Pool bulge."

In order more easily to demonstrate this bulge, the patient stands with heels together and with head and shoulders thrown backward.

This posture tightens the rectus abdominis and emphasizes the peculiarity, which consists of an oblique bulge, above and parallel with Poupart's ligament and extending outwards from the lateral margin of the rectus towards the crest of the ilium.

In many normal individuals a slight bulging may be seen in this region, but the wide departures from the normal, encountered in some of our cases, will be readily recognized from the accompanying illustrations. (See Figs. 2, 3, 4, 5, 6, 7.)

Usually the bulge is symmetrical and of the same degree on the two sides.

That such a configuration might play a part in the etiology of inguinal hernia, especially of the acquired varieties, or increase the liability to recurrence after operation, led us to look further into the matter.

Careful examinations for this condition were made in fifty consecutive admissions for inguinal hernia in the male, and of these, 80 per cent. showed an abnormal bulge.

INGUINAL HERNIA IN THE MALE

Of the oblique hernia cases, 74.2 per cent., and of the direct hernia cases, 92.3 per cent. showed the "Pool bulge."

For control a series of fifty consecutive male admissions, free from inguinal hernia, was similarly examined and 30 per cent. of abnormal muscle bulges were found.

Our examinations therefore showed that the muscle bulge was two and one-half times more frequent in hernia patients than in persons free from hernia.

The average age at examination of the hernia cases was 28.5 years. A marked bulge was found in four cases under ten years of age, the youngest being only four years old.

As regards recurrences of hernia in cases showing the abnormal "bulge," our records show 20 per cent. recurrence for direct hernia, as against 16.6 per cent. for all direct herniæ.

Similarly the oblique recurrences were higher in cases with the bulge, *i.e.*, 5.3 per cent. as contrasted with 3.0 per cent. for all oblique operations.

Thus the recurrences are seen to be above the average, but perhaps less so than might have been expected.

Possible explanation of the bulge may be found in one or more of the following factors:

- (a) Congenital anatomical defect.
- (b) Poor development of otherwise normal muscle.
- (c) Stretching, relaxation or thinning of the muscles from malnutrition, etc., but especially from faulty standing posture which favors visceroptosis.
- (d) Defective innervation.

It seems fair to assume from our observations that such a weak muscle conformation does play an important rôle in the etiology and prognosis of inguinal hernia, especially of the direct types, and the surgeon should hesitate before counselling operation on a direct hernia associated with a pronounced bulge of the muscles.

Recognition of this peculiar muscle bulge must be made when examining patients in the follow-up clinic, lest one mistake it for an incipient recurrence.

There were nine instances in our traced cases where at early return examinations the bulge was regarded as presaging a recurrence, but subsequent and repeated examinations over a period of several years failed to show any recurrence of the hernia.

ADMISSIONS FOR RECURRENT INGUINAL HERNIA

There were performed 61 operations for recurrent inguinal hernia in the series of 1093 consecutive operations, or 5.6 per cent.

The recurrence rate in our own 978 traced cases is 7.46 per cent.

It is evident that not all cases which recur are willing to submit to secondary operations, although a certain number of individuals show apparently undaunted confidence in surgery and submit to repeated attempts at a cure.

Two cases in our series were operated for the third time, and two others for the fourth time for one hernia.

The comparison of admissions to a hospital for recurrent hernia, with the total admissions for inguinal hernia over a certain period of time, will always underestimate the actual percentage of recurrence following inguinal hernia repair.

The follow-up clinic of to-day proves this to be so.

Regarding the disposition of the 73 known recurrences in our present series, it may be stated that already 17 cases, or 23.3 per cent., have been reoperated by us; about 10 per cent. have been operated upon at some other hospital; of the remainder, some have declined operation, others present as yet no clear indication for operation, and still others by reason of their age or infirmity have been advised against further operation.

One very great advantage of the follow-up clinic has been the early recognition of incisional herniae, especially following appendectomy, leading to the early, hence very satisfactory, repair.

RESULTS IN FIFTY-TWO OPERATIONS FOR RECURRENT INGUINAL HERNIA

Among 52 traced operations for recurrent inguinal hernia, there are 12 known secondary recurrences, or 23.1 per cent.

TABLE V.
Type of Operation Used For Recurrent Hernia.

	Oblique Operated	Secondary recurrences	Direct Operated	Secondary recurrences
Bassini.....	8	1	11	2
Bassini plus rectus.....	2	0	3	0
Cord not transplanted.....	6	1	1	1
Cord transplant extra-apo- neurotic.....	3	0	14	4
Atypical.....	1	1	3	2
Total.....	20	3 or 15%	Total 32	9 or 28.1%

This table shows the high rate of secondary recurrences after operations for repair of already recurrent hernia.

TYPES OF HERNIA FOUND AT RECURRENT OPERATIONS

In five instances the so-called recurrence resulted from a failure to find and eradicate a direct sac at the primary operation.

In every operation for inguinal hernia careful examination should be made on both sides of the deep epigastrics to determine the possible presence of a "saddle-bag" sac, one portion of which may readily be overlooked.

In our 52 traced cases, we have descriptions of the primary operation in 26 instances; the others had been operated upon in other cities or in other lands.

INGUINAL HERNIA IN THE MALE

Where the primary operation is known, thirteen were direct sacs at the first operation and all but one of these were found to be direct at the secondary operation; the one exception followed the extra-aponeurotic transplantation of the cord and recurred as an oblique sac issuing forwards through the cord exit at the internal abdominal ring.

The thirteen cases known to be oblique primarily showed nine oblique recurrences and four direct recurrences; the latter type may well have been due to failure to correct a "saddle-bag" sac at the first operation.



FIG. 6.—Case 195. Marked "muscle bulge" persisting after operation for bilateral direct hernia. No recurrence of hernia. Followed for five years.

Including cases not subsequently traced, there were 61 operations for recurrent inguinal hernia.

Oblique sacs were found in 24 instances, and we assume that in all but the one instance just described the primary operation had been for oblique hernia.

Direct sacs were found in 28 cases; direct-indirect sacs in 9 cases; therefore at secondary operation some form of direct hernia was the outstanding feature in 37 individuals.

Of these 37 direct recurrences, we have stated that at least four followed a primary operation described as being for oblique sacs, and it is likely that is true of some others of whom no previous record could be obtained.

We conclude that the vast majority of all herniæ recur in their primary type.

Seven sliding herniæ were found in the series of recurrent herniæ.

ACCIDENTS AT OPERATION

The femoral vein was injured with a needle in one case but a lateral ligature was applied and recovery was uneventful.

The small intestine adherent in a sac was opened into, in one instance, and despite the immediate suture of the gut, the wound became infected and the hernia recurred.

The vas deferens was unintentionally divided in six cases, but without demonstrable ill effects later; none of them showed atrophy of the testis nor complained of impotence, pain or other symptoms.

Among the 1093 operations, the bladder was in no instance opened.

ADDITIONAL OPERATIONS

1. Appendectomy through the hernia incision was performed in 77 of the earlier cases in this series, but was discontinued as a routine procedure and is only employed when the appendix presents itself readily, because of the danger of hemorrhage or infection due to inadequate exposure.

2. Non-descended testes were found in 20 cases and were treated by the Bevan method without transplantation of the cord.

In following up these cases the testis has usually remained in the upper third of the scrotum, although in three cases it was found well down in normal position.

Within the space of years covered by our follow-up examinations we have failed to note any demonstrable increase in size of the replaced testis; indeed, in over half of the cases (11 cases), the examiner, at a later date, has classed the case as persistent atrophy of the testis.

3. Unilateral orchidectomy was performed in five cases for the following indications:

Case No. 911 had orchidectomy for tuberculosis of the testis and epididymis.

Case No. 729 was a man aged 64 years, with a very large, recurrent direct hernia which was irreducible in the scrotum.

Case No. 983, a man of 62 years with a large incarcerated oblique scrotal hernia.

Cases Nos. 443 and 682, aged respectively 29 and 43 years, each had a very small atrophic nondescended testis, high in the inguinal canal, which could not be brought down into the scrotum.

In every case consent had been obtained before operation.

In Cases Nos. 729 and 983, the problem of a firm repair was found easier after the orchidectomy and both have remained cured up to date, *i.e.*, over three years.

4. Division of the deep epigastric vessels was practiced in 23 cases with wide-mouthed sacs of the direct-indirect type, with the view to converting the double sac into one.

Up to date, five have recurred, or 21 per cent.

INGUINAL HERNIA IN THE MALE

Therefore little can be claimed for this procedure, *per se*, unless it contribute to the operator's convenience.

Ordinarily, the vessels may be readily pushed off from the sac, either laterally or mesially, so as to permit of adequate exposure.

One case, No. 524, died of pulmonary embolism following division of the epigastrics, and autopsy revealed a thrombus extending from the stump of the epigastric vein downwards into the femoral.

POST-OPERATIVE COURSE

Duration of Hospital Treatment.—In uncomplicated cases the stay in the

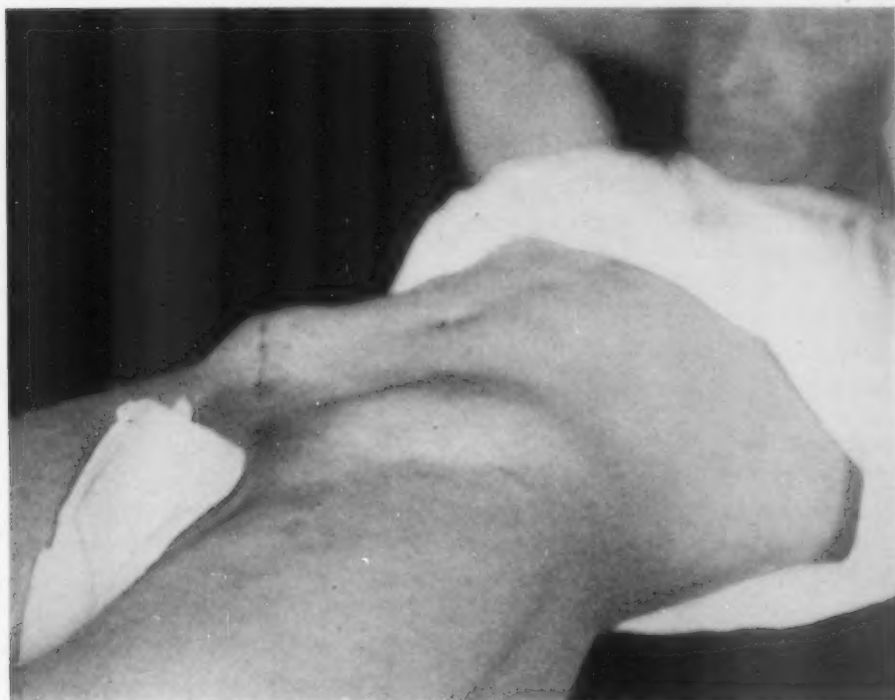


FIG. 7.—Illustrating "muscle bulge" in the reclining posture, with head lifted.

hospital after operation for oblique hernia averaged 13.7 days, and for direct hernia the average was 15.8 days.

Wound Infection.—In the series of 1154 consecutive inguinal hernia operations, male and female, there occurred 55 cases of wound infection, or 4.8 per cent.

This includes even the slightest and most superficial stitch abscess, as well as the 11 more serious infections.

The average hospital stay of these 55 cases was 22.3 days, being approximately one week longer than the normal average.

The 11 deeper infections (0.96 per cent.) were the only cases whose hospital stay exceeded four weeks; but there are already four known recurrences in this group.

SEWARD ERDMAN

The percentage of known recurrences for all grades of infected cases is 10.9 per cent., considerably above the normal rate.

One death, Case No. 567, resulted from erysipelas commencing in an infection of the hernia wound.

DELAYED INFECTIONS

There were seven cases where the hernia incision healed per primam but who returned to the hospital dispensary from three to twenty weeks later with a subcutaneous infection, requiring drainage.

The average interval after operation was from four to six weeks, although in one instance the interval was three and one-half months and in another instance five months.

Mechanical or chemical irritation about a non-absorbed suture with a latent, low-grade infection, was accepted as the explanation; particularly about the deep sutures of kangaroo tendon.

Since January, 1920, linen thread has been used as a substitute for kangaroo tendon, but already we have seen several cases of delayed infections about a linen suture.

POST-OPERATIVE SCROTAL TUMEFACTIONS

In an earlier communication based upon a study of 148 inguinal hernia operations, occurring in the first and second year of the present five-year series, I stated that "the bedside notes revealed 56 cases of demonstrable adventitious swellings in the scrotum, almost immediately after operation, an incidence of 37.9 per cent. These swellings were much more frequent after operation for oblique hernia, *i.e.*, 48 per cent.; whereas after direct hernia there were 15.2 per cent."

"There were found 20 early hydroceles of the tunica vaginalis among the 56 tumefactions in the 148 hernia operations."

At that time an attempt was made to classify the swellings and to explain the etiology.

It was further stated that "many of the tumefactions are of little more than academic interest—and in less than three months more than half of them have entirely disappeared."

A plea was made for the utmost gentleness in dissection and the least possible handling of the cord.

In our present study, based upon the post-operative notes on 1093 male hernia operations, we noted 144 scrotal tumefactions, or 13.1 per cent.

There were 51 (or 4.66 per cent.) early hydroceles, demonstrated by aspiration, which yielded on the average from 20 to 60 c.c. of clear yellowish serum.

These figures are much more conservative than those of the earlier report, perhaps due to less thorough examination and notations during the exigencies of the World War period, but certainly in part attributable to more

INGUINAL HERNIA IN THE MALE

careful technic at operation and by abandoning the practice of reconstructing a tunica in cases of congenital hernia.

Of the 51 post-operative hydroceles, 9 could not be traced, leaving 42 cases which have been followed and whose course ran as follows:

- (a) Disappeared within four months, 15 cases.
- (b) Disappeared between four and twelve months, 17 cases.
- (c) Persisting over one year, 10 cases.

The hydroceles when first noted, in from one to three days after operation, were usually small collections of fluid which might easily be overlooked on casual examination.

Early aspiration was practised on over 80 per cent. of our cases and repeated several times if indicated, which treatment may explain the disappearance in many cases.

The ten cases which have persisted more than a year bid fair to become permanent, unless operated upon, as three have already been.

In addition to the definite hydroceles, there were 93 other post-operative tumefactions, which we have attempted to classify as distention of veins above the testis; thrombosed veins; thickening of the tunica, after excision and turning back of the same; hæmatomata; epididymo-orchitis, as evidenced by swelling and induration of the testis and epididymis, probably from œdema.

More than half of these swellings disappeared completely within three months, others persisted as small fibrous irregularities along the cord or about the testis.

Of greatest importance is the fact that nine of the cases classed either as hæmatoma or epididymo-orchitis subsequently showed atrophy of the testis after disappearance of the primary swelling.

Very few scrotal swellings occurred in direct herniæ.

PERSISTENT PAIN

Among the 978 traced cases there were 11 cases who complained of pain in the groin or scrotum over periods of from three months up to two and one-half years.

One case had a large varicocele, not operated, a possible factor in the etiology of the pain.

Two cases had developed post-operative epididymo-orchitis.

Two cases had a recurrence of the hernia.

One case had had a large scrotal hæmatoma, which had required drainage.

In the five remaining cases, no explanation for the pain is offered, either by the findings at operation or the early post-operative course, but probably represent some form of nerve involvement.

ATROPHY OF THE TESTIS

There were found 15 cases of post-operative atrophy of the testis, not counting 10 cases of non-descended testis, where atrophy of the replaced testis continued as before operation.

Nine cases out of the fifteen, developed atrophy of the testis after an early post-operative swelling, especially epididymo-orchitis. Four others occurred after difficult operations for recurrent scrotal herniae, requiring much dissection and handling of the cord. The two remaining cases are not explained by the records.

1. The usual Bassini operation with transplantation of the cord beneath the aponeurosis was used in 717 cases and yielded 7.33 per cent. of recurrences.

TABLE VI.
Results From Different Types of Operation in 978 Traced Cases.

Type of Operation.	Oblique Hernia		Direct Hernia	
	Operations	Recurrences	Operations	Recurrences
1. Bassini.....	532	17 or 3.2%	185	29 or 15.67%
2. Bassini with rectus.....	13	0	35	4 or 11.4%
3. Cord not transplanted.....	112	3 or 2.67%	25	7 or 28.0%
4. Extra-aponeurotic transplant of cord.....	8	1 or 12.5%	64	10 or 15.62%
5. Atypical repair.....	0	0	4	2 or 50.0%
Total.....	665	21 or 3.0%	313	52 or 16.61%

It is perhaps the best single operation for all the different types of inguinal hernia if one had to be limited to any single operation; but for children under the age of fifteen years, non-transplantation of the cord as recommended by Ferguson is better suited and less injurious for reasons we have already stated.

For direct hernia, the Bassini operation yielded 15.67 per cent. recurrences, which result is far from ideal and urges one to seek for some operative procedure which will prove more satisfactory.

2. Bassini with rectus. This modification of the Bassini operation by which the edge of the rectus muscle, or a portion of its sheath, is brought down and sutured to Poupart's ligament, was used in 48 cases with somewhat better results than in the simple Bassini.

3. Non-transplantation of the cord, as in the Ferguson and in the Johns Hopkins operations, is well suited to the treatment of oblique hernia in the young; but we believe that it is not the logical method of repair for direct hernia.

In 25 cases of direct hernia thus treated by us, we had 28.0 per cent. recurrences.

In the Johns Hopkins series, where non-transplantation operation was presumably employed, there were reported 29.7 per cent. recurrences among the total of 47 direct hernia cases which were submitted to reëxamination at that hospital.

4. Extra-aponeurotic transplantation of the cord, in reality a modification of the original Halsted operation, was used in 72 instances in our series of

INGUINAL HERNIA IN THE MALE

978 traced cases, chiefly for direct hernia (64 cases). The recurrence rate after this operation in direct hernia was 15.62 per cent., being practically the same as after the Bassini.

At first glance, these figures appeared disheartening, when one considers that this procedure was undertaken in the effort to improve results.

It must be stated, however, that the cases selected for this type of operation were, almost without exception, cases in which the problem of a successful repair promised to be a difficult one; thus, in five instances the sacs were extremely large and of long duration; in 16 cases the hernia had already recurred one or more times; in 22 cases the age was over fifty years and the age average for this group was forty-two years.

Objections have been voiced to this method of extra-aponeurotic transplantation, on the grounds that the superficial position of the cord might unduly expose it to trauma, or be painful.

In only two of our 72 cases was persistent pain complained of, and in each of these cases the operation was for a recurrent hernia.

One case showed atrophy of the testis; this also was an already recurrent hernia.

Only one of the recurrences after this type of procedure occurred at the site of the internal abdominal ring; all others recurred as direct herniae.

At present we employ this method for the more difficult of the direct herniae and whenever the muscles are markedly deficient.

IMPROVED TECHNIC FOR GASTRECTOMY AND GASTRO-ENTEROSTOMY

BY LEONARD FREEMAN, M.D.

OF DENVER, COLO.

IN surgical operations it is important to develop a technic that will produce the best results in the simplest manner. With this object in view, I venture to suggest a method of performing gastrectomy, gastro-enterostomy and other similar operations which has proved to be unusually easy and effective in the instances in which I have employed it.

The objections to the ordinary methods are quite evident. For instance, rubber-covered forceps used singly, or combined into a rather expensive and cumbersome three-bladed instrument, may crush the mucous membrane, thus leading to hemorrhage or ulceration, as emphasized by Coffey and others. Some surgeons have even given up their use on this account. Also, under certain conditions, the broad blades of the forceps may occupy too much valuable space, and it is then, especially, in one's desire to prevent slipping, which cannot always be done, one may clasp the instrument with damaging tightness. This applies particularly to high resections of the stomach, to the unloosening of old gastro-enterostomies and to Finney's pyloroplasty.

Certain specially devised clamps tend to obviate some of these difficulties, but not all of them, and in addition these clamps have disadvantages of their own.

The use of the suture alone may be quite satisfactory in experienced hands, but it requires much practice and technical skill. The average surgeon is apt to approach it with hesitation, because of the absence of hæmostasis and the possibility of soiling the field of operation.

Operative Technic.—The special equipment consists of two mattress needles, a foot or so in length (long needles used in the manufacture of mattresses and to be obtained in most hardware stores). Also four Allis-forceps and several ordinary rubber bands about one-eighth inch in width.

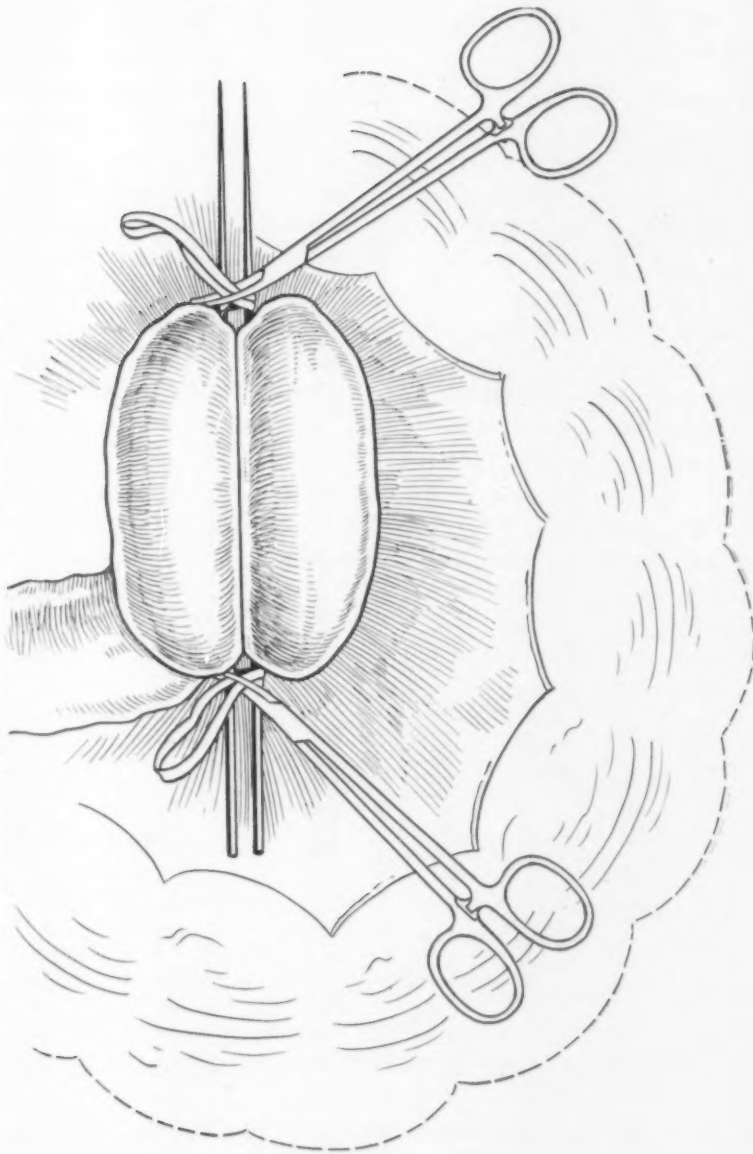
In gastro-enterostomy, after exposure of the stomach and jejunum, a fold is picked up from each with the Allis-forceps and brought alongside of each other in the position in which they are to be united (Fig. 1). A mattress needle is then placed well down on either side of these folds, pressing them closely together into two prominent opposed pouches, such as are formed when forceps are used (Fig. 1). While the needles are held in place by an assistant, a rubber band is wound around their ends upon either side, tightly enough to bring the elasticity of the bands into play, and clamped with forceps (Figs. 1 and 2). The operation is then completed in the usual manner.

The advantages of this procedure are several:

Its simplicity and ease of performance.

TECHNIC FOR GASTRECTOMY AND GASTRO-ENTEROSTOMY

FIG. 1.—Showing application of needles in performance of gastro-enterostomy.



The impossibility of injury to the mucous membrane, owing to the mildness of the elastic pressure and its uniformity, depending upon the fact that the needles, unlike forceps, are everywhere parallel to each other.

The small amount of room occupied by the needles as contrasted with forceps, which may be of great importance.

The unlikelihood of slipping, because the small diameter of the needles permits them to sink slightly into the soft tissues. If, however, in an excep-

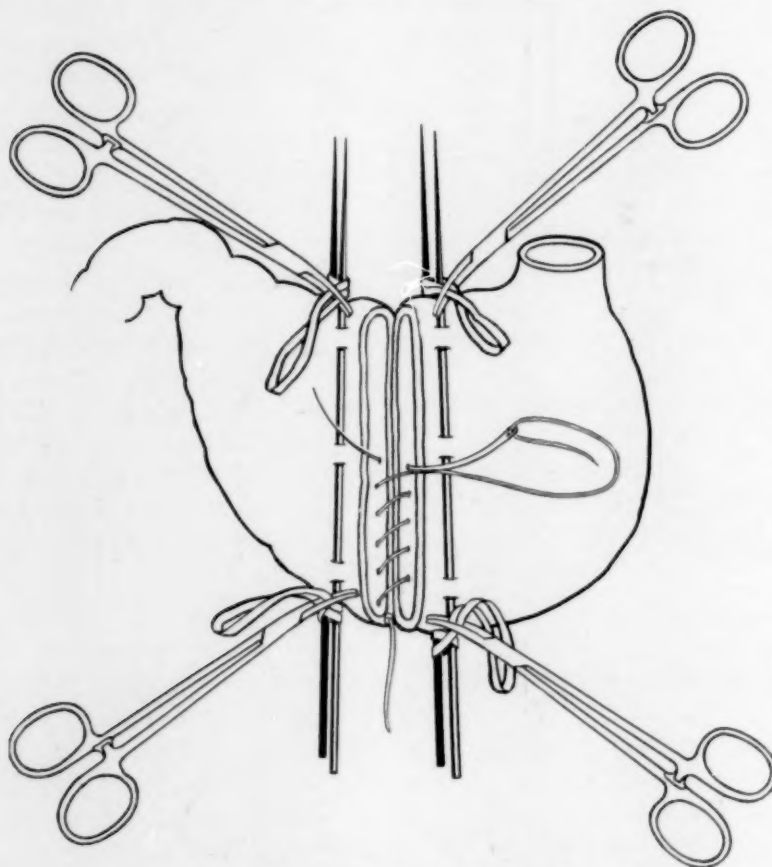


FIG. 2.—Showing method of application in gastrectomy.

tional instance, slipping is feared, one or both of the needles may be made to catch up a little of the peritoneum in one or more places, which will insure their retaining their positions (Fig. 2).

And lastly, the fact that the pouches are pressed firmly together, without the intervention of forceps, which not only facilitates suturing, but also does away with the necessity of placing gauze between the intestinal loops to prevent soiling.

In gastrectomy, the advantages are marked, especially when a high division of the stomach is called for. After freeing the organ, a mattress needle is

TECHNIC FOR GASTRECTOMY AND GASTRO-ENTEROSTOMY

placed on either side, above the proposed line of section. In order to obviate the danger of slipping, so common with rubber-covered forceps, the needles are stuck in and out at several points, through the external coats of the stomach, without penetrating its lumen. Care is taken that one of these points is near the upper and one near the lower border in order to hold the gastric arteries with certainty (Fig. 2). The rubber bands are then applied as already described.

It is obvious that the stomach and its vessels will now be firmly held and closed, without danger of slipping or of injury to the mucosa, and with the sacrifice of a minimum amount of room, which perhaps is not the least of the advantages. Crushing clamps will of course prevent slipping; but, in addition to occupying valuable space, it is questionable whether the severe injury to the tissues is not detrimental to smooth healing.

Other uses of this method in connection with operations about the stomach will suggest themselves; for instance, in Finney's pyloroplasty, where forceps are too large and clumsy to be used easily and are apt to slip, a fold from the stomach and one from the duodenum can be elevated with Allis-forceps and clamped together so as to include the pyloric region, running the needles through the subperitoneal tissues at a few points when this seems necessary. Likewise, in operations for restoration of the *status quo ante* in poorly-functioning gastro-enterostomies, it is quite easy to handle the stomach with needles where it would be difficult with sutures alone, owing to the likelihood of spilling the gastric contents; or with rubber-covered forceps, because they occupy too much room and are too liable to glide from the comparatively small stomach-fold with which one is often compelled to work under very unfavorable conditions. Shorter needles, obtained by cutting off portions of the longer ones, may occasionally be desirable.

THE LIMITATIONS OF THE OCHSNER TREATMENT IN CERTAIN CASES OF SUPPURATIVE PERITONITIS*

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AND

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It is impossible to discuss the limitations of the Ochsner treatment of appendicitis and peritonitis at the present time, without first reviewing the attitude of the surgical profession to that method. The omission of such a review would lead to the erroneous impression that we assume that it had been generally accepted by the profession at large. It is now many years since its distinguished advocate, whose name it bears, first presented it to the attention of the surgical world, and during that time the pendulum of opinion as to its place and value has not ceased to swing toward and away from its more general adoption. It was advocated as a method of physiological pre-operative treatment of a condition in which operation was universally attended by a high mortality. It yielded, in the hands of its originator, and of many of his followers, results that seemed to them vastly superior to those achieved by other and more precipitate methods of treatment, methods which were characterized by immediate or early operative intervention. It has, however, never commanded anything like universal attention, and it seems to us from a review of the literature of the last six years, that it is perhaps less popular to-day than when we last reviewed this subject in 1916. Our opinion as to the present attitude toward the Ochsner treatment is based partly on a study of the literature of this country, and of Europe, and partly on personal observations and communications.

As we have remarked before, it might properly be spoken of as an American method of treatment of peritonitis, and this, not because of its universal adoption in this country, but because it has won scanty recognition abroad. Personally we have long been convinced of its value as a substitute for immediate operation in certain cases of acute diffuse peritonitis, a conviction based in part on personal experience and observation, and in part on the study of reports of large series of cases treated by this and other methods. While nothing has shaken our faith in it as a general principle of treatment, we realize, from the published reports from clinics, large and small, in this country and abroad, that it has not the place in surgical favor which one would have expected to find after a favorable experience with it.

An analysis of statistics from many sources would indicate that the general mortality from acute appendicitis has been lowered within the last few years. The general recognition of the value and safety of immediate operation in the

* Read before the American Surgical Association, May 2, 1922.

OCHSNER TREATMENT IN PERITONITIS

early hours of an acute attack, and the emphasis laid by teachers on the necessity of early recognition, has, in this country at least, reached almost a generation of medical students. To-day there is a unanimity of opinion in America at least, as to the necessity of immediate intervention in this group. It is also true that this opinion is not of universal adoption in some European countries, notably in France, where we find the surgeons divided into interventionists, abstentionists and opportunists, which are strangely unfamiliar names to us.

When we come to study the attitude of surgeons everywhere toward the treatment of an acute and established peritonitis, we find some authority for almost every conceivable method of treatment, and time of intervention. There is no consensus of opinion as to the choice between immediate intervention and delay with pre-operative treatment. We have been able to classify to a certain extent the opinions as to the method of choice into the following rather imperfectly defined groups.

1. The first group would include those surgeons who are in full accord or close agreement with a waiting policy in all cases of peritoneal infection after the first two days. The time limit we have mentioned, but we believe it an unfortunate practice to measure sharply the progress of intra-abdominal pathology in terms of hours. The element of time is a feature of the anamnesis which must be carefully considered. It must, however, be correlated with the symptoms and the balance struck in terms of probable and not absolute truth as an index of pathology and a guide to treatment. Otherwise grave mistakes will be inevitable. While the names in this list are very weighty in authority, their number seems surprisingly small.

2 This group includes a list of authorities, many foreign, who consider delay advisable under certain circumstances, but we find among them a diversity of conflicting opinions as to the time of operative intervention, but a practical unanimity of disagreement with or disregard of the teachings of the first group. By them operation is rather reserved for the exact class of cases in which we have been accustomed to avoid it, viz., those in which the symptoms, local and general, are unfavorable or very grave. Abstention from operative interference in acute appendicitis when emphasized seems to us to miss the point entirely, that is operation when it can be practiced most favorably, and before peritonitis develops. At this stage experience teaches us that the mortality is almost negligible. Extremely long delay is counselled in cases of abscesses of some standing in the hope of further absorption or of rupture into the bowel. Large collections alone are considered favorable for the operation. This list is a long one, and contains many of the best known names in French surgery

3. A large group with many leading American surgeons among its adherents. Here we find no mention of the Ochsner method or its equivalent. Advice is against delay under any circumstances or on any grounds except in the moribund. In this group are many adherents, who, if they practice what they teach, lose no time after making a diagnosis, but operate at once.

If we attempt the difficult task of weighing the evidence in favor of one or the other of these methods of treatment, as advocated by the different groups, it leads us into a maze of statistics. These share the common features of a rather low combined mortality for appendicitis cases in general. Analyzed with respect to the mortality of operation for acute diffuse septic peritonitis, they show a range of mortality in what might be styled the intermediate stage, of from 17 per cent. to 65 per cent. in most series. Now and again we find a record of some very large series of undifferentiated cases with a mortality almost nil. When such a series is credited to one or two individuals in a clinic, one may be pardoned for wondering to what assistant is assigned the desperate risks, and what his feelings and mortality may be.

That there is still a considerable number of cases which reach the surgeon when in desperate condition there can be no dispute, at least such has been our experience. It would seem as if we had reached the limit in this direction of the education of the medical profession. But we still encounter too frequently the case that has been purged on one ground or another, or on general principles. A procrastinating policy, with desire to avoid the unpleasant responsibility of urging operation or surgical consultation explains many other cases. Honest mistakes in diagnosis in the hands of careful surgeons and experienced practitioners contribute a small but ever present percentage here as elsewhere. Where the majority of cases are referred by members of a staff in close touch with its activities, the number of late cases is small. Where the contrary holds true it is larger.

We would reiterate our adherence to the general principles of the Ochsner treatment. There are certain limitations, not sufficiently emphasized, which have been impressed upon our minds by personal experiences.

Generally speaking, in young children it is difficult to carry it out in its entirety, and sometimes unsafe. Starvation means an early onset of acidosis aside from that dependent upon sepsis. The vital resistance of tissues including the peritoneum to the encroachment of sepsis is much less. Witness the quiet but rapid progress of a peritonitis in the earliest stages of a suppurative appendicitis at this age. The danger of metastatic infection in remote regions, as the subphrenic space, the lungs and elsewhere, is greater. In the doubtful cases at this age we incline to immediate operation in all except the moribund.

A strong indication for immediate intervention is met with in cases in which the question arises as to origin of the peritonitis, and the diagnosis is confused between that of appendiceal origin, and peritoneal irritation or infection from perforative lesions of the gastro-intestinal tract of other types. There are cases of pyloric ulcer especially in which the history of pre-existing gastric or other disturbance is unobtainable at the time of surgical consultation. All surgeons have encountered cases of this type and have operated at times on a mistaken diagnosis of appendicitis. If a rigid policy of abstention is pursued in the face of a lingering doubt, added fatalities will result.

OCHSNER TREATMENT IN PERITONITIS

A very important group, and one little touched upon, we have encountered several times of late. These are cases of acute free perforation of a pre-existing appendiceal abscess, giving rise to a violent peritonitis. The following case histories will illustrate the salient features in this class:

N. D. W., age thirty-one, had suffered for years with so-called bilious attacks. Present illness began with abdominal pain and vomiting. For two days was not confined to bed, suffered intermittent pain, and dosed himself with rhubarb and soda. Pain returned with great severity the evening of the day we saw him. When first seen at about 9 P.M. he was suffering excruciating abdominal pain. His abdomen was very rigid throughout. There was an entire absence of peristalsis on auscultation. Pulse 80 and of good volume, temperature $100^{\circ}/_{10}$, leucocytes 8400. He was sent to the Bryn Mawr Hospital, and placed upon the Ochsner treatment. There was marked improvement for 36 hours. Leucocytes rose to 13,000. The abdomen became softer, a mass formed in the right iliac region, there was some return of peristalsis, the pulse was good, at times irregular (he had long had an arrhythmia) and he was in general rather comfortable. On the evening of the second day he was not so well. He had vomited a bilious material, there was no action of the bowels, and it was thought best to operate. Section revealed a very extensive peritonitis in the lower abdomen and pelvis. The appendix had sloughed off at its base, and fecal matter was escaping from the opening in the cæcum. The small intestine was still distended and paralyzed. There was a foul collection around the cæcum, and the pelvis was the site of a large collection of yellow pus, which we took to be an abscess of older date than that associated with the diffuse peritonitis at a higher level. A drainage operation was performed with difficulty, and reaction followed in this desperate case. For two weeks he made a determined fight against peritoneal sepsis and intestinal obstruction. Enterostomy was done later with temporary relief, but the patient succumbed suddenly to cardiac paralysis, while still exhibiting symptoms of the above mentioned complications.

In this case we believe it would have been better to have operated immediately. While it might seem, *a priori*, that a peritoneum capable of localizing an acute infective process in the first instance, should be able to repeat the performance, yet we believe that rupture of an abscess is an exceedingly fatal occurrence, a second localization rarely taking place.

An insufficient amount of attention has been paid to this accident. It is rarely observed in cases under rigid hospital regimen. If operation be not too long delayed under such conditions it almost never occurs. General sepsis may supervene from unreasonable delay. Obstruction is seen more frequently and subphrenic abscess may develop and make the most astonishing progress if not recognized. But rupture if it occurs in such cases usually takes place by perforation into the bowel. But in all acute cases admitted during the stage of acute peritonitis, the possibility of rupture of an abscess into the general peritoneum must be remembered. There is usually the history of an attack of several days' duration, although here again we must avoid the mistake of measuring pathology solely by time. With this there is commonly the history of sudden exacerbation of acute abdominal symptoms, especially pain. Shock is a frequent and striking symptom, with circulatory failure, amounting at

times to collapse. The abdominal rigidity increases and may become as board-like as that seen in perforated pyloric ulcer. The leucocyte count is sometimes extraordinarily low. All these symptoms point toward an acute abdominal invasion inconsistent with the presence of a diffuse peritonitis of slow extension and long duration. Under such circumstances we believe the urgent indication is for operation at once.

Even a delay of a few hours is likely to prove fatal in this complication, owing to the extensive contamination of the peritoneum.

F. C. L., age forty-five, treated by physician for several days as a case of enteritis, or abdominal grippe. Had been allowed up, when he was taken very ill in the morning while at stool, with severe pain, accompanied by collapse. When seen at the Presbyterian Hospital that afternoon, he exhibited the signs of a general peritonitis. His condition was not good, his pulse 120, the abdomen characteristic. Leucocytes 6400. It was deemed wise to operate at once. When opened the abdomen showed a diffuse general peritonitis, and an abscess in the pelvis, of older date, which had recently ruptured into the general peritoneum. It owed its origin to a gangrenous appendix. Appendectomy and drainage were performed. There was scarcely temporary improvement, and the patient died on the third day after the operation of septic peritonitis.

The following case recovered with immediate operation:

Dorothy D., age two years, eleven months. Sick three days with a diagnosis of appendicitis. Had not been seen by a surgeon. The history had been quite typical but her physician was striving to avoid operation. She had pain off and on throughout the attack, but the night preceding the day on which we saw her, which was the third day of her illness, it had been more severe. On that day also she vomited for the first time. There was no marked change in her condition, however, until early in the afternoon of the third day, when she went into a condition of shock. When seen by us three hours later, she had reacted from the collapse which had alarmed her physician and family, and presented the usual evidences of appendicitis, with what was evidently a diffuse peritonitis. The rigidity and tenderness were not extreme. Her general condition was fair, and her temperature elevated. She was removed to the Bryn Mawr Hospital and operated on the same evening. Temperature on admission $103\frac{1}{4}$, pulse 140. On opening the abdomen a thick-walled and well defined abscess was discovered, around a rather high perforated appendix; the abscess had undergone recent and spontaneous rupture. Retraction without the slightest disturbance of the relations showed a thin stream of pus trickling down into the comparatively clean peritoneal cavity. There was not the slightest doubt in our minds that the collapse which had been noted in the afternoon, and which may have been preceded by some exertion, had marked the first involvement, or rather re-involvement of a peritoneum which had once successfully combated the infection, but which could hardly be trusted to do so again. Appendectomy and drainage were followed by a very smooth and prompt recovery.

It is true that operation in this stage will yield a considerable number of fatalities. It is unlikely, however, that a peritoneum that has once successfully resisted the gradual or free rupture of a suppurating appendix can again combat such flooding with pus of frank and highly virulent nature.

OCHSNER TREATMENT IN PERITONITIS

Again, there are other types of appendicitis in which the onset of peritonitis may be attended by and due to a volume of infection similar to that seen in acute intestinal perforation of traumatic origin, or even a ruptured abscess. Two such types are the rupture of a large appendix, distended with pus, or the perforation, near its base, of a patulous appendix, which permits free leakage of fecal matter into a peritoneum not shut off by pre-existing adhesions. Such accidents may be delayed long beyond the 48-hour time limit arbitrarily fixed for the period of immediate intervention. Delayed pathology is the explanation, and in the presence of such a picture of acute abdominal catastrophe, the necessity of immediate operation needs no argument for its support.

Finally, it is well to remember that a too rigid adherence to any rule of practice may be followed by regrettable mistakes. Dogmatic and sweeping statements are perfectly justified in teaching immature student minds which must first grasp the main principles. Many of the authorities we have studied have changed their views so radically that one may be pardoned for wondering whether they must not sometimes regret their former unreconcilable attitudes.

Judgment is developed by experience, and while we cannot always explain the mental processes by which the masters in surgery arrive at quick and correct decision, we must admit that it is by reason of such ability that they are masters.

Any one who believes that the treatment of appendicitis has been standardized even in its main essentials should review the literature of the last few years. It is no longer voluminous, and except for a recent flurry before the Society of Medicine in Paris, not even controversial. It would seem that different clinics and different geographical localities have settled down to established practices with which they are content, though those practices are often diametrically opposed to those in vogue in other clinics of equal standing. There is general agreement on only one point, namely, that the management of this disease should be delegated to the surgeon.

However, when the patient reaches the surgeon he may find himself in the hands of what the French call an "interventionist" who will operate upon him at once, regardless of the stage of the disease or his general or local condition. Or especially if he be in France, Switzerland or parts of Germany, he may find his surgeon an "abstentionist" who will not operate in the acute stage unless after a period of observation it is evident that the patient has failed to improve or perhaps is worse. Again using the handy French division, the surgeon may be an "opportunist" who will operate at once if the attack has lasted no more than 36 to 48 hours, but after that will wait for conditions to improve or even resolve entirely before risking operative intervention. This is the old strife for the interval operation, and such names as Jalaguier, Tuffier and Walther are still connected with it. Témoin of Bourges has recently launched a most determined attack upon this plan and heads the "interventionists" in France. As yet they are in the minority. In England, during the last six years, no one has raised his voice for delay in

operation upon any type of case. In America, our patient probably would be subjected to immediate operation regardless of the stage of the disease or his condition, but there is a fair chance that he might enter a clinic whose policy it is to treat certain cases of appendicular peritonitis by the well known principles of anatomic and physiologic rest, hoping for localization before operation. It is impossible to secure pure and homogeneous statistics to settle the relative superiority of these various plans. Low mortalities are claimed for each by their respective adherents.

It seems clear that the usual case of early appendicular peritonitis should be operated upon without delay with the reasonable expectation that the peritoneum will take care of the infection already liberated. It seems equally clear that the same group of cases, properly and rigidly treated by anatomic and physiologic rest, can in the vast majority of instances be brought to subsidence or localization, conditions which permit operation with very low mortality. Failures will occur in each group, but if we can judge by reported results the mortality figures will not differ greatly. Now we know that by far the greater part of the mortality from appendicitis comes from the group which exhibits when first seen a widespread peritonitis with evidences of profound systemic toxæmia, and usually in the third or later days of the disease. Leaving aside the question of elimination of this type of case by more timely recognition, it is evident that the reduction of surgical mortality must deal chiefly with this group. Those who have made use of Ochsner's plan cannot fail to have been impressed with the general improvement and localization of the peritoneal process that may occur in seemingly desperate cases. Nor can they have failed to note that other cases exhibit no such tendency but proceed to generalization and death. On the other hand, those who practice immediate operation must often have had the experience that the post-operative condition of the patient is obviously worse than before operation, and death results from progressive toxæmia, within a few hours or days. It does not seem likely that the deaths in both groups affect the same individuals under such different forms of treatment. Can we not further define our indications for and against immediate operation? Are there not cases undergoing localization or capable of localization which yet present the signs of widespread peritoneal irritation and marked general toxæmia? We believe there are and that precipitate operations in this group will often determine a fatality, when rational pre-operative measures will bring safety. On the other hand, there are certainly cases that show no tendency towards localization and will inevitably perish under any waiting policy. In the body of this paper we have made a plea for recognition of certain types which are likely to fall into this group, notably: (1) Young children, (2) cases of delayed and fulminating gangrene or perforation and (3) intra-abdominal rupture of a localizing or localized abscess. Such conditions can at times be reasonably surmised from the history and clinical conditions, and such evidence should take precedence over inflexible rules based upon ideas of a pathology which does not always run true to form.

OCHSNER TREATMENT IN PERITONITIS

The following brief summary of the literature of the last five years is appended to show the extraordinary variety of views still maintained in regard to this question which many of us have come to regard as trite and practically standardized:

A. J. OCHSNER reiterates his belief in the plan formulated in 1892 and carried out by him ever since. The cases in which delay is practiced are not clearly defined, but in general it is implied that cases of beginning diffuse peritonitis of over 48 hours duration, are so treated. In previous publications, however, Ochsner has indicated clearly his views and treatment.

JOHN B. DEEVER says, "in progressive peritonitis, usually of more than 40 hours, it is safe to presage a fatal outcome if operation be undertaken in the presence of symptoms of diffusing peritonitis—rapid running pulse, abdominal distention, cyanosis of the *facies Hippocratica*—while delay may save the patient in such cases."

EUNICKE recommends delay in operation upon diffuse peritonitis, gastric lavage for vomiting, warmth to the abdomen, saline solution by bowel and camphor hypodermatically. Operation is to be undertaken when improvement occurs.

SEHRT advises delay in cases which show in the fifth to the tenth day the outspoken picture of peritonitis, associated with prostration, rapid pulse, often vomiting and a large area of dullness in the right iliac fossa. His "conservative therapy" consists of a few teaspoonfuls of cold tea, cold red wine and frequent mouth washes with cold water, moist applications on the abdomen, no opium. He does not operate unless the general condition is good, even waiting in some cases of localized abscess for spontaneous rupture into the intestine.

LÖFFLER (Hochenegg's Clinic), in a highly statistical paper, reports 463 cases, of which 406 were operated. Very mild cases were treated without operation, and all were cured or relieved. Several of these were operated upon because their symptoms were progressive. Any sign of peritonitis was an absolute indication for immediate operation.

BEVAN states that immediate operation is best in all cases; but those which cannot be given the benefit of early surgical treatment; in doubtful cases; and in advanced age or serious organic contraindications. These cryptic rules are not elaborated, but he further says, "I now operate at once, regardless of the day of admission." It seems a fair inference from the exceptions that Bevan has in mind a group of cases in which a period of delay is advisable before operation.

PAUCHET (Amiens) advises early operation in all cases except in mild cases of several days' duration when medical treatment is permissible; in cases showing marked symptoms and serious outlook, operate if within 48 hours of onset; in abscess formation, wait for an opportune moment; in generalized peritonitis, he says, "I believe that if it were possible to secure comparable statistics on these cases operated upon by different surgeons, or left to themselves, the mortality would be almost the same, with or without intervention." He believes "the average surgeon will get the best results by letting them alone."

HARTMANN (Paris) advocates immediate operation in all cases except abscesses (which he treats expectantly), and in the face of a serious general condition of the patient.

JALAGUIER (Paris) prefers to wait for the interval, if symptoms are mild. "In the immense majority of cases of ordinary and easily recognizable types, rigorous expectant treatment should be instituted. In a few hours one is settled." If symptoms persist or increase, operate at once. Otherwise wait. Hospital management under the surgeon's care is imperative, as urgent symptoms may arise at any moment and demand immediate intervention. If the patient is in a state

of collapse when seen, stimulate and wait a few hours before operation. He claims 3 to 4 per cent. mortality in acute cases, and admits that he operates more freely than formerly. (Note that this plan is in many respects the reverse of Ochsner's treatment. The more serious the condition, the more urgent the operation, except in the case of collapse.) No statistics are given.

TUFFIER (Paris) states that he was formerly a partisan convinced, and a defender of the immediate operation in all cases, but that he has little by little retreated from this position, and his practice is identical with that of Jalaguier.

QUÉNU shares the views of Jalaguier and Tuffier, but he says he operates in some cases in the acute stage.

GOSSET, BERGER and LENORMANT agree substantially with Jalaguier.

WALTHER operates immediately, if seen within 48 hours. After this time, if the case is improved, he delays; otherwise operates. He prefers to treat appendicular abscesses expectantly, awaiting absorption or spontaneous rupture into the bowel. He reports 700 cases, mortality 3.85 per cent. In the period 1913-1919, 162 cases; 2 deaths; 1.23 per cent.

BAZY advocates in typical, advanced, general peritonitis, multiple incisions and drainage under local anæsthesia. Of 35 cases, 24 died; 68 per cent. Of the 24 deaths, eleven died within 24 hours. He defines a group suffering from marked toxæmia and extensive peritonitis in which he prefers to await localization. In general, he holds with Témoïn, that intervention should be the rule, and waiting the exception.

ALEXANDER reports cases of acute appendicitis in children with 15 deaths; mortality 3 per cent. He states that the only type of acute appendicitis with diffuse peritonitis in which delayed operation is advisable and justifiable, is when the patient is seen after 2, 3 or 4 days of illness, and presents vomiting, general abdominal tenderness, absence of peristalsis, marked abdominal distention, slight cyanosis with rapid pulse and dry coated tongue.

REHN advises immediate operation on all cases, as soon as diagnosis is made, regardless of stage, extent or localization.

EICHHOFF employs Rehn's method; reports 69 abscesses operated, with 3 deaths, 4.4 per cent., 47 cases of free purulent exudate (peritonitis) with 9 deaths, 19 per cent. Only one of these deaths occurred in cases operated upon in the first 24 hours. The series is not so analyzed as to demonstrate the effect of immediate operation in the *late* cases of diffuse peritonitis. The mortality is almost limited to this group.

JENCKEL gives no consideration to delay in cases of diffuse peritonitis. Of 830 cases, 31 died, 3.7 per cent.; 62 of these showed diffuse peritonitis, 22 died, 35.4 per cent.; 46 of the latter are analyzed with reference to stage, as follows:

20 operated upon within 24 hours	1 died
12 operated upon within 48 hours	4 died
13 operated upon within third day	13 died
1 operated upon on seventh day	1 died

It is evident that the late cases could not have fared worse if operation had been postponed.

HUGHES summarizes essentials of operative treatment of diffuse peritonitis without reference to the principles of the Ochsner treatment.

OCHSNER TREATMENT IN PERITONITIS

CRILE reports 407 consecutive operations for acute appendicitis by Lower and himself, without a death. This is a brief article enunciating Crile's principles of treatment, and makes no mention of Ochsner's treatment. Unfortunately, no statement is made concerning the disposition of cases of late and widespread peritonitis.

LAROCHE justifies delay only in order to get patient to competent surgeon and proper surroundings; or to enable a more thorough operation when a combination of pathology is present. No mention is made of Ochsner's plan, and the two exceptions above noted do not touch upon the crux of the question.

BEEKMAN, SMITH and EVERINGHAM reported 500 operative cases, representing the work of many different surgeons in the Cornell Division of Bellevue Hospital, New York; interesting statistical study: highest mortality period begins after the second day of the disease, which parallels similar statistical studies quoted from McWilliams, DeQuervain and combined Berlin hospitals. There were 45 cases of diffuse peritonitis; of these, 12 were of less than 2 days duration; all recovered. By inference, the remaining 33 were of more than 2 days duration; 21 died, 63.3 per cent. No mention is made of Ochsner's treatment, or of any indications for delay and pre-operative treatment in this group. Immediate operation is counselled because of the difficulty in making a diagnosis from the symptoms, "severe cases often showing the least marked signs."

KRECKE (Munich) practices immediate operation in all severe cases.

HAGEN (Augsburg) agrees with Krecke.

ROWLANDS (*Guy's Hospital*) counsels immediate operation in all cases. "If competent surgeon is not available, adopt the Ochsner conservative treatment, . . . an operation must be undertaken if signs of localized abscess or peritonitis develop."

TÉMOIN (Bourges) is the strongest French advocate of immediate operation in all cases, regardless of time or condition. He presents large statistics with remarkably low mortality: report of 1911 gives 1442 acute cases, 37 deaths, 2.5 per cent. In the later group, 169 showed "more or less general peritonitis" with 25 deaths, 14.7 per cent.

CAUCHOIX concurs with Témoign.

NICOLL dismisses the waiting policy with the remark that "the patient who is shocked as the result of flooding of the peritoneal cavity with pus, will scarce be improved if the surgeon tides him over his shock only to allow him to be overwhelmed with the sepsis of the untreated focus of infection."

BANCROFT reports 485 acute cases from the New York Hospital; mortality, 4.3 per cent. There were 73 cases of acute diffuse peritonitis; 13 died, 17.8 per cent. mortality. There is no discussion of the advisability of delay in any type.

MORF reports 822 cases from the Cook County Hospital, Chicago; the total mortality is 7.4 per cent.; 26 cases were classed as diffuse peritonitis; 17 died, mortality 65.3 per cent. There is no discussion of delay in operation in any type of case.

SLOAN states that his experience with the waiting policy has been bad, and advises immediate operation in all cases. Eisendrath, in discussion, dissented so far as to advise "abstaining from operation in those desperate cases where the pulse is 160 or 180, and they are simply gone." Five other surgeons in discussion agreed with Sloan in advising immediate operation in all cases.

MARTIN DU PAN, in an excellent article on the treatment of peritonitis, outlined the accepted methods in use in France. He advocates immediate operation.

JOPSON AND PFEIFFER

RUNYON advocates combining the methods of Ochsner and Crile. He remarks that "many of our cases we thought would die if not operated immediately, and usually died when so operated, would not only not die when let alone, but would in a short time become safe operative risks." Pre- and post-operative treatment is to be carried out according to Crile's recommendations.

CHIARI (von Haberer's Clinic) states that the practice in this clinic is to operate immediately on every case admitted within forty-eight hours after onset. After the third day, immediate operation is advised unless the case is obviously improved and the inflammatory signs giving evidence of localization. He reports 1167 cases, of which 717 were operated in the acute stage, mortality 6 per cent.; 450 operated in the interval, with two deaths; of 81 cases of diffuse peritonitis, 30 died, 37 per cent. These cases are practically all of more than forty-eight hours' duration, and were all operated immediately after admission. As to the advisability of delay in this group, he quotes the mortality statistics of other clinics, dealing in the same manner with the same type of cases, as follows:

GREKOW	45	per cent.
THIEMANN (Riedel's Clinic)	62	per cent.
KROGIUS	39	per cent.
PROPPING (Rehn's Clinic)	40	per cent.
ZAHRADNICKY	40	per cent.
HAGEMANN	25.4	per cent.

BROWN (England) shows clearly the high mortality of the intermediate stage as compared to the safety of the early and later operation, and attributes this to breaking down the barriers to infection before general resistance has been built up. However, following the English custom, he advocates immediate operation at whatever stage the case is seen.

VOGEL (formerly Kocher's Clinic) does not clearly define indications for operation in his long statistical paper. Evidently the interval operation is preferred, but severe cases are operated immediately, regardless of duration or condition. The result appears to be unfavorable; thus of thirty-six cases operated upon by simple incision, with or without irrigation, thirty-one died. It is noted that all cases that entered the hospital in collapse, died in a few hours after operation.

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OCHSNER TREATMENT IN PERITONITIS

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SPONTANEOUS INTRAPERITONEAL RUPTURE OF THE BLADDER

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IN a strict application, the term spontaneous should probably be reserved for a type of bladder rupture dissociated from any trauma whatsoever, either from within or from without. Such cases have been reported, but it will probably be admitted that a comprehension of them involves some tax upon the imagination. Certainly it is difficult to conceive of a bladder gradually distending until it passively permits itself to burst, entirely without any expulsive reaction on the part of its own musculature or of the correlated musculature of the abdominal wall.

It may be appropriate therefore to apply the term to the case to be reported, though it is definitely associated with such trauma as may be represented by the straining efforts of the patient to overcome a prostatic obstruction. No other traumatic element is apparent in the case.

Many instances of rupture of the bladder are recorded in the literature. Usually the injury is associated with distention and an external shock. The distention may be due to prostatic obstruction, stricture, neglect of micturition during drunkenness or other causes. Rising out of the protecting wall of the pelvis and inelastic from over-stretching, the bladder is in such circumstances subject to serious harm. The external shock causing the rupture may come in the form of falls upon the feet or buttocks or abdomen, blows or kicks over the region of the bladder, crushing injuries, the lifting of heavy objects, and so on. The most usual forms of internal trauma are straining at stool, micturition, or during parturition. The recorded cases of rupture of the bladder from indirect force are comparatively rare and those associated only with the so-called internal trauma are exceedingly uncommon. The case to be reported would appear to illustrate two main points:

1. The desirability even in what seems a simple diagnostic situation of carefully weighing unusual symptoms and signs although they may suggest a condition so unusual as to be almost unknown to the observer.
2. Further confirmation of the recorded observation that the peculiar arrangement of the musculature of the bladder wall on its posterior superior aspect makes this the weakest part of the organ, the vulnerability of which is still further increased by the fact that here it is covered only by peritoneum and intestines whereas elsewhere it is encircled by muscles and bones.

CASE REPORT.—K. E. colored, married, male, aged sixty. Entered Memorial Hospital on April 6, 1920, with immediate history of complete retention of urine for forty-eight hours and antecedent history of difficult urination for two or three years with marked frequency day and night. In the present attack,

INTRAPERITONEAL RUPTURE OF BLADDER

which was his first acute retention, his physician had attempted to pass a rubber catheter but failing to do so had sent him to the hospital.

Examination showed a well-nourished negro apparently in no more distress than would be expected from a distended bladder. His temperature was 100, and his general condition very good. There was no abdominal rigidity but a fluctuating suprapubic mass could be felt extending to the umbilicus. The fact that this mass was more diffuse and less sharply defined than is usually the case with a full bladder was made a matter of comment between the attendant and the interne at the time being, but its true significance was not appreciated. Rectal examination disclosed a huge prostate and very little further attention was given to the diagnosis. The case seemed to present a commonplace picture of acute retention from prostatic obstruction, indicating suprapubic cystotomy. A rubber catheter could not be passed into the bladder but a woven prostatic catheter entered; about an ounce of urine ran out and the flow then stopped. It was assumed that a middle lobe had probably dropped over the end of the catheter and another point, which, in conjunction with the diffuse character of the suprapubic swelling, would have been most helpful toward a true diagnosis, was thereupon misinterpreted, mainly because the possibility of the occurrence of the condition actually present had never entered the mind of the writer.

As suprapubic cystotomy seemed clearly indicated, no further manipulations were made and the patient was removed to the operating room. Under procain anaesthesia the usual suprapubic incision was made. Beneath the recti muscles was found a bulging and cedematous structure which suggested peritoneum but appeared too thick and opaque for it. It did not give the tense sensation of a distended bladder, but, as evidently nothing lay beneath it except fluid, it was tentatively assumed to be the thinned-out bladder wall, and incision was made directly into it. The immediate escape of a large amount of fluid, evidently urine, appeared to confirm the supposition. A finger was inserted through the opening to explore the prostate, and while this manipulation was in progress a knuckle of small intestine insinuated itself between the finger and the upper angle of the incision, revealing an actual invasion of the peritoneal cavity. A general anaesthetic was thereupon administered, the incision enlarged, the fluid in the abdomen, amounting to nearly a gallon, evacuated, the intestines packed off and a thorough inspection made. The bladder was found collapsed in the bottom of the pelvis and on its posterior superior aspect about one and a half or two inches above the posterior peritoneal reflection was a rent large enough to permit the easy passage of two fingers. The edges of the hole were sharply congested and somewhat indurated. The peritoneum was stripped back and closed around two intraperitoneal drainage tubes in such a manner as to exclude the ruptured area of the bladder. The indurated margin of the bladder opening was then excised and closure made from above and below around an intravesical tube. The superficial structures were closed in layers as usual. Microscopic sections of the excised tissue showed no evidence of ulceration or other local condition at the site of rupture.

The immediate post-operative history of the patient was remarkably satisfactory. There was at no time any evidence of serious peritoneal involvement although his urine showed a considerable amount of pus. His temperature went up to 101, but promptly came down and his pulse did not exceed 100. Two days after operation his blood urea nitrogen was 88 mg. and his blood-pressure was 160, 110. His abdomen continued soft, his bowels moved promptly and regularly, suprapubic drainage continued very free, and he was soon eating heartily and apparently on the road to a good recovery. In the light of his operative findings, further inquiry was made into his history. The only additional fact of importance

elicited was to the effect that on April 5th, the day before he entered the hospital, and some twelve or fourteen hours after the onset of his acute retention, he had been straining for some time in an effort to empty his bladder when he suddenly had a pain in his abdomen and, as he expressed it, he "got sick as a dog." He rallied fairly promptly and his only other symptom was mild nausea without vomiting. It was at this time, twenty-four hours before his operation, that the rupture of his bladder probably occurred.

On April 12th, the patient got out of bed while asleep, walked up and down the corridor and lost his dressings as well as the tube in his bladder. He was apparently none the worse for this experience. His renal function reading on the same day was 55 per cent. in two hours.

For the next two months the record was made eventful only by an occasional brief spell of temperature, usually coincident with some obstruction to the bladder drainage which in the main was very free. The specific gravity of the urine fluctuated between 1004 and 1020 but blood-pressure remained fairly steady in the region of 140, 90. Renal function as measured by the dye output varied between 40 and 60 per cent. Urea nitrogen dropped to 17mg. and then to 14mg. After an unusually long stationary period the prostate began to diminish in size. In spite of his excellent progress it appeared desirable, in view of the unusual experience through which he had passed, to defer the added strain of prostatectomy as long as possible, and under ordinary circumstances the patient would have been sent home for several more weeks of drainage. As the character of the attention he would have gotten at home was, however, highly questionable, and as his condition at this time was probably far better than it would have been later after a period without intelligent observation, it was determined on June 22nd to attempt prostatectomy without further delay. The gland was exceedingly difficult to enucleate and came away in several pieces. The extreme density of some areas suggested malignancy but microscopic sections showed nothing but the usual hypertrophy. The patient made a good recovery from this operation and on July 24th, he returned to his home. At that time his suprapubic wound had closed and he was voiding a normal amount of urine through his urethra.

The above case, with introductory observations, was reported before the Richmond Surgical Society in December, 1920. Its existence was recalled to mind by a recent publication* in which Thomas reports certain experiences with intraperitoneal rupture of the bladder. An excellent review of the literature accompanies this article. Thomas notes the infrequency of the condition, the very scanty text-book or other data, the original gloomy prognosis, the gradual improvement in the meagre surgical statistics, and the still remaining high mortality rate. In 1882 Rivington in his Hunterian lecture declared that he doubted "whether a single unequivocal recovery after intraperitoneal rupture of the bladder has occurred." Six years later Walsham collected seventeen cases in which abdominal section was done. In three the rupture was extraperitoneal; two died and one recovered. Suture was effected in eleven of the intraperitoneal ruptures; five recovered and six died. Simple drainage without suture was done in the other three; one recovered and two died.

Still further improvement was noted in Jones' statistics which in 1903 contained reports of 54 cases. The mortality rate for the entire series was 48

* Intraperitoneal Rupture of the Bladder, by T. Turner Thomas, M.D., *ANNALS OF SURGERY*, vol. lxxvi, No. 1, p. 64, July, 1922.

INTRAPERITONEAL RUPTURE OF BLADDER

per cent. In 32 cases previous to 1893 the mortality rate was 63.5 per cent., while in 22 cases between 1892 and 1903 the rate was 27.5 per cent. In the following year Dombin and Papin collected 78 cases with a general mortality of 43.5 per cent. and a mortality between 1895 and 1904 (34 cases) of 20 per cent.

The cause of death is usually peritonitis, shock or hemorrhage. In the case here reported, the patient exhibited no evidence of shock when first seen and gave no history of it except his statement of "feeling sick as a dog" when the rupture occurred. There had apparently been little or no bleeding from the bladder wound. In spite of the presence of a large amount of urine no peritonitis was present when the abdomen was explored and no indication of it subsequently developed. This latter observation emphasizes Thomas' statement that free escape of urine into the peritoneal cavity does not necessarily lead to a fatal peritonitis and would appear to carry it a step farther and indicate that it may actually occur, though probably very rarely, without any peritoneal inflammation whatever.

Thomas comments at length upon the difficulty of accomplishing an effective suture of the lower part of a rent in the posterior or peritoneal wall, where the rupture usually occurs. In the first of his two cases the closure was poor and the patient subsequently developed peritonitis from leakage of urine. In his other case a perfect closure was effected, but the patient died in a few hours. The difficulty of closure he charges to the anatomical relationship of the bladder, its deep position behind the pubis when contracted and the absence of laxity in the bladder wall. He recites similar difficulties of suture encountered by other operations and suggests, with Jones, the beginning of the suture line at the upper angle of the wound, employing each successive stitch as a tractor to draw the rent upward within easier reaching distance. In the writer's case a free exposure was possible and suture could have been effected throughout except for the apparent desirability of vesical drainage pending the future prostatectomy. The separation of the peritoneum from the bladder contributed to this freedom of exposure and the exclusion of the abdominal cavity in this way from the suture line in the bladder would appear to commend itself as a general surgical proposition when it can be accomplished.

In some of the reported cases the bladder wall was sutured throughout and the abdomen closed without drainage, and a certain number of the cases recovered. Notwithstanding the absence of signs of peritonitis, the writer preferred a safety valve in the shape of an intra-abdominal drain, removed as soon as it was demonstrated that no complications were developing. In all the reported cases in which suture was imperfect or not attempted, simple drainage was used, and in quite a number recovery and subsequent perfect restoration of bladder function occurred in spite of the free leakage of urine into the peritoneal cavity and a subsequent prolonged suprapubic discharge. In further confirmation of the ability of the peritoneum to handle successfully an outpouring of urine, Thomas cites two cases of operative injury to the bladder without repair, both patients recovering after simple drainage.

THE MECHANISM OF THE FORMATION OF URINARY CALCULI*

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IN the study of the etiology of urinary concretions we deal with an abnormal type of crystalline precipitation. The constituents of urinary stones include uric acid, urates, calcium oxalate, calcium phosphate, calcium carbonate, ammonium magnesium phosphate, and less often, cystin or xanthin. These materials are all insoluble in water, even within the range of acidity or alkalinity which we find in urine. Crystals of these substances are often found in the urine of normal persons. Usually they are isolated, single, unfused and perfectly formed according to the crystallographic system peculiar to the given material. To ascertain what mechanism is at fault in causing the atypical deposition and fusion of these crystals into a stony concretion is the problem discussed here.

The power of the urine in health to hold these constituents of calculi in solution, or to bring about their deposition as isolated entities, is due to the presence of finely divided particles of organic matter, the so-called protective colloids.¹ The urinary colloids are incompletely known, but are supposed to include the urinary pigments, traces of nucleo-albumin, mucin, and albuminous material from effete cells cast off from the renal parenchyma. The reaction of the urine and the body temperature are also important factors in maintaining urinary solution. Thus highly acid urines will carry more phosphate, oxalate, and carbonate in solution than those which are near to or on the alkaline side of neutrality. Again, uric acid and cystin attain a greater solubility in alkaline urines. However, it must be emphasized that the hydrogen-ion concentration is a secondary factor in maintaining solution, as is evidenced by the relative insolubility of stone constituents in water of the same degree of hydrogen-ion concentration as the urine.

Ebstein and Nicolaier, in 1891, studied the chemical nature of urinary calculi and for the first time produced stones in the urinary tract of animals by feeding oxamid, a derivative of oxalic acid. As the result of their studies these authors held that the inflammatory reactions in the kidneys resulted in the precipitation of urinary salts in the matrix furnished by the exudate, and thus in some obscure way stone had its genesis.

Rainey, in 1856, and later Ord and Shattock, determined the physical principle that colloidal matter *in vitro* would modify crystalline morphology.

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FORMATION OF URINARY CALCULI

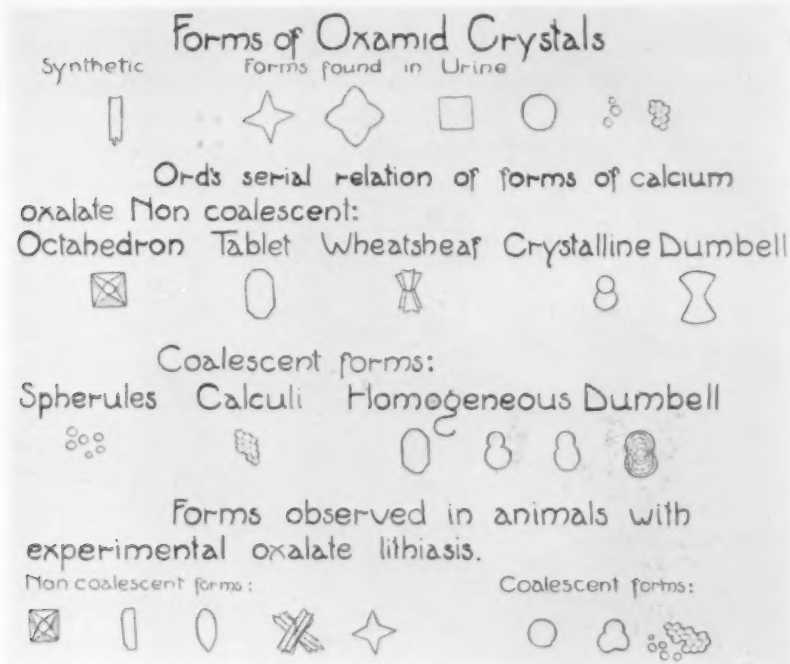


FIG. 1.—A diagrammatic sketch of the serial relationship of non-coalescent and coalescent forms of oxamid and of calcium oxalate crystals. W. M. Ord in 1871 recognized the power of colloids *in vitro* to modify the morphology of crystalline matter and traced the relationship of non-coalescent and coalescent varieties of calcium oxalate as shown above. Later he showed with Shattock that the coalescent forms constituted the structural units of calculi as seen microscopically.

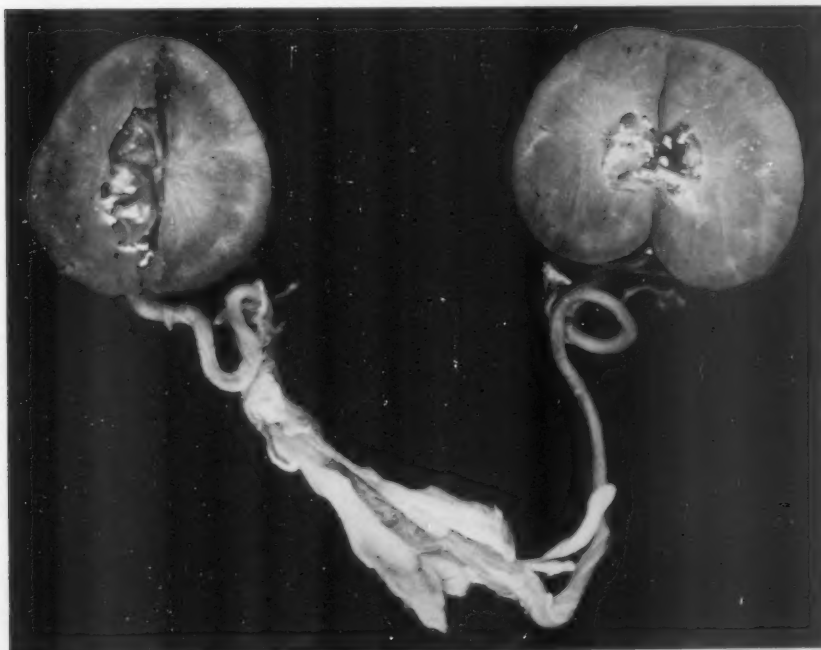


FIG. 2.—Lithiasis from feeding oxamid to rabbit seventeen days.

Thus crystals of oxalate and carbonate of lime would be precipitated from water solution and from solutions containing gelatin, mucin, albumin, and other colloids in widely different forms. Ord, working with calcium oxalate, could trace a number of morphologically related forms which varied consistently according to the amount of colloid and salt present. Furthermore, he found that certain of these crystals tended to remain isolated, while others, especially the spherical forms, tended to fuse. Thus he distinguished between coalescent and non-coalescent varieties of calcium oxalate crystals.

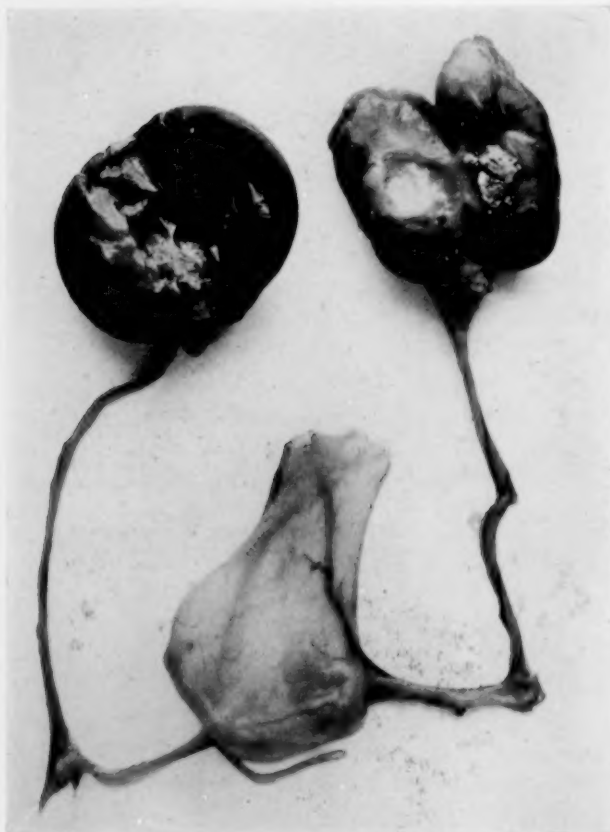


FIG. 3.—Formation of oxamid calculus around organic nucleus placed in the renal pelvis. Oxamid was fed for fifty-four days.

Figure 1 shows these related forms of calcium oxalate in a schematic manner.

Ord's study of the microscopic structure of urinary calculi of oxalate and uratic types led him to the conclusion that the mechanism of their formation might be related to colloidal matter in urine. The demonstration of this relationship, however, remained to be shown.

During the past two years the experimental production of calculi has been studied by the feeding of oxamid. The details of this study are published in another report, but in brief the results were as follows: Synthetic oxamid (diamido-oxalic acid) on being fed to rabbits

and dogs was found to be excreted as such, in the urinary tract. On being deposited from the urine it assumed an entirely different crystalline morphology from that of the synthetic product fed. The crystals had changed from a non-fusing to a fusing or coalescent variety, this fusion of crystals leading to stone formation (Figs. 2 and 3). The process seemed to be related to the urinary colloids as the reaction of the urine did not interfere with the process and as the synthetic oxamid crystals, when dissolved by heating in animal urine, would be reprecipitated on cooling with a morphologic change to the

FORMATION OF URINARY CALCULI

fusing spheroidal crystalline types. In Figs. 1 and 4 the relationship of the forms of oxamid crystals seen in animal urines may be traced. It is easily seen that the coalescent spheroids are developed from a fundamental cross form.

These experiments suggested that stone formation might be due to one of several factors: (1) The excretion of an excessive quantity of crystalline material beyond the power of the urinary colloids to maintain either solution or deposition of isolated non-coalescent crystals; (2) a deficient amount of

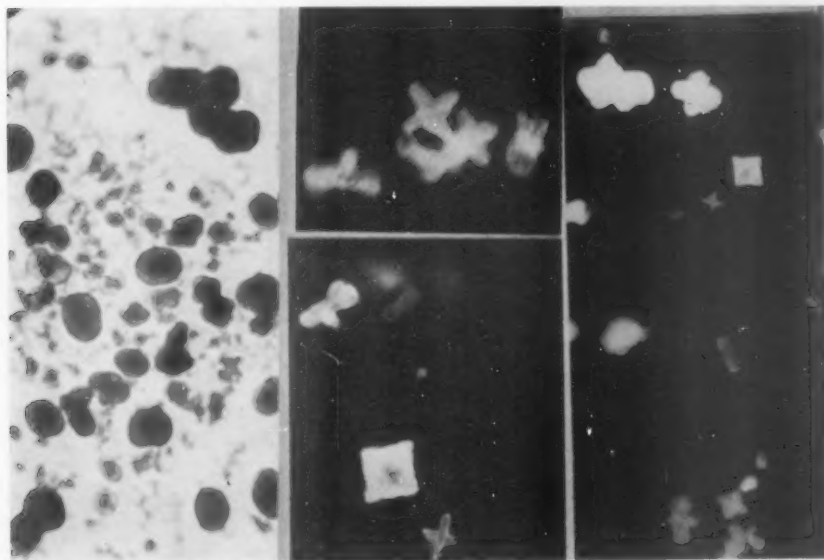


FIG. 4.—Oxamid crystals as observed in urine under the influence of the urinary colloids. These crystals have assumed a morphology altogether different from the synthetic form. We can trace the evolution of crystals through non-coalescent crosses, crosses with interbranchial spaces partly filled out, squared forms and coalescent spheroids.

protective colloid in the urine, and (3) the precipitation of normal colloids or masking of their protective activity by bacterial exudates, or by foreign colloidal matter excreted as the result of an abnormal metabolism. Experimental proof of these points has thus resolved itself into three problems.

LITHIASIS FROM EXCESSIVE CRYSTALLINE EXCRETION. EXPERIMENTAL CALCIUM OXALATE CALCULI

The difficulties encountered in attempting to increase the visible crystalline content of the urine in substances normally present proved formidable. Aside from the experiments of Minkowski and of Ebstein and Nicolaier, who demonstrated small deposits of uric acid in the renal epithelium of animals after the intravenous injection of massive doses of piperazin uric acid or the feeding of large quantities of adenin to dogs, and the finding of occasional

calcium oxalate crystals in the tubules after oxalic acid poisoning, no success in this direction had been obtained. The administration of various solutions of uric acid phosphates and oxalates likewise met with failure in our hands, the oral, muscular and intravenous routes being used.

We then planned a procedure whereby one of the urinary salts could be indirectly concentrated in the blood stream, thus leading to an excess secretion in the urine. As the oral administration of oxalic acid was known to cause the visible appearance of calcium oxalate crystals in the urine, an ester of oxalic acid was used. Normal butyl oxalate was chosen as being adapted to this purpose. It is an oily liquid which can be easily administered subcu-

taneously and it presents the oxalate ion in slight concentration. It may be assumed that on subcutaneous injection it is absorbed and slowly becomes hydrolyzed in the blood stream. The oxalate radical thus liberated combines with the calcium present in the blood and thus calcium oxalate is formed. In order to prevent a marked diminution in the normal blood calcium, a chemically equivalent amount of calcium chlorid in solution was given simultaneously under the skin. In certain instances marked necrotic local reactions in the skin occurred as a result of the injection of these irritating chemicals, and some animals had to be prematurely killed. However, in a number of instances a series of subcutaneous injections were satisfactorily made for



FIG. 5.—Experiment 126. Calcium oxalate stones in bladder, produced by subcutaneous injection of normal butyl oxalate and calcium chlorid.

a number of days consecutively. In this manner we produced intense oxaluria for a relatively long time.

By this method definite urinary calculi were produced in ten rabbits in a series of approximately fifty attempts (Figs. 5 and 6). Many of the animals died, or were killed, during the first few days of the experiments because of cutaneous necrosis mentioned above, or because of the intense nephritis due to the oxalate poisoning.

Table I indicates the duration of life, dosage of oxalate ester and calcium chlorid administered, and the oxalate deposits found at necropsy in a series of fifteen animals carefully studied. One other experiment (Experiment 28), in which 1 c.c. of butyl oxalate and 0.4 gm. sodium oxalate was given daily for six days, gave positive results. Twenty small stones, 2 by 1 mm., were found in the bladder.

FORMATION OF URINARY CALCULI

TABLE I.

Experiment	Days fed	Nitrogen butyl oxalate, c.c.	Calcium chlorid, 10 per cent. solu- tion, c. c.	Total nitrogen butyl oxalate, c.c.	Total calcium chlorid, 10 per cent. solution, c.c.	Findings
125	6	0.3	1.6	1.8	9.6	Sand in bladder; slight amount in kidneys
126	5	1.0	5.0	5.0	25.0	Sand and calculi in bladder (Fig. 5); no deposits in kidneys
127	3	1.6	8.0	5.0	24.0	No gross deposits. Microscopic deposit of crystals in tubules intense
128	6	0.3	1.6	1.8	9.6	Granules and sand in bladder. Slight amount in calyces
129	8	0.3	1.6	2.4	12.8	Sand in right kidney and small stones in calyx of left kidney. No granules in bladder
130	6	0.5	2.5	3.0	15.0	Sand in both kidneys and bladder
131	4	0.6	3.0	2.4	12.0	No gross deposits
132	24	5.5	2.5	132.0	60.0	Sand in calyces of both kidneys; 2 stones in bladder; ulcerative cystitis with incrustation calcium oxalate (Fig. 6)
133	2	1.0	5.0	2.0	10.0	No deposits; unsatisfactory
134	24	0.5	2.5	12.0	60.0	Small stones in left kidney and bladder; no deposits in right kidney
135	2	0.4	2.0	0.8	4.0	No deposits in calyces or bladder; microscopic deposit crystals in tubule intense
136	28	0.5	2.5	14.0	70.0	Small stones in left kidney and bladder
137	7	0.5	2.5	3.5	16.5	Six small stones in bladder; no deposits in calyces of kidney
138	14	0.5	2.5	7.0	35.0	Small stone in calyx of right kidney; 1 stone and sand in the bladder
139	12	0.5	2.5	6.0	30.0	No deposits in calyces of kidney; several small stones and granules in bladder

FEATURES OF THE EXPERIMENTS REQUIRING ESPECIAL EMPHASIS

1. Rabbits weighing between 2 and 3 kg., whose urine gave no growth on culture, were chosen.
2. Variable amounts of sand were almost consistently found in the urinary tract of the animals. In approximately one-fifth of them the kidneys or bladder contained definite calculi.
3. Cultures made immediately after death from the kidneys and from the bladder urine were consistently negative for bacterial growth. The only

exception to this was in Experiment 132, in which the animal had lived twenty-eight days and had an ulcerated bladder with oxalate incrustations. A Gram-negative bacillus was grown from the bladder urine.

4. The sand granules and calculi were found to be composed of calcium oxalate.

Crystallography of Experimental Oxalate Lithiasis.—A daily study of the urinary sediments from animals receiving the butyl oxalate-calcium-chlorid mixture revealed certain remarkable features from the standpoint of

crystallography. The octahedral form of calcium oxalate is well known. A few hours after the injection of the initial dose of butyl oxalate and calcium chlorid this octahedron was found in the urine. Successive increments of urine showed the oxaluria becoming more intense and as this took place tabloid, dumb-bell, and finally spheroid types of calcium oxalate crystals made their appearance in rapid succession. With the appearance of the spheres, fusion or coalescence of the crystals into little clusters or clumps was noted. Figure 7 shows typical sediments in which the different varieties of

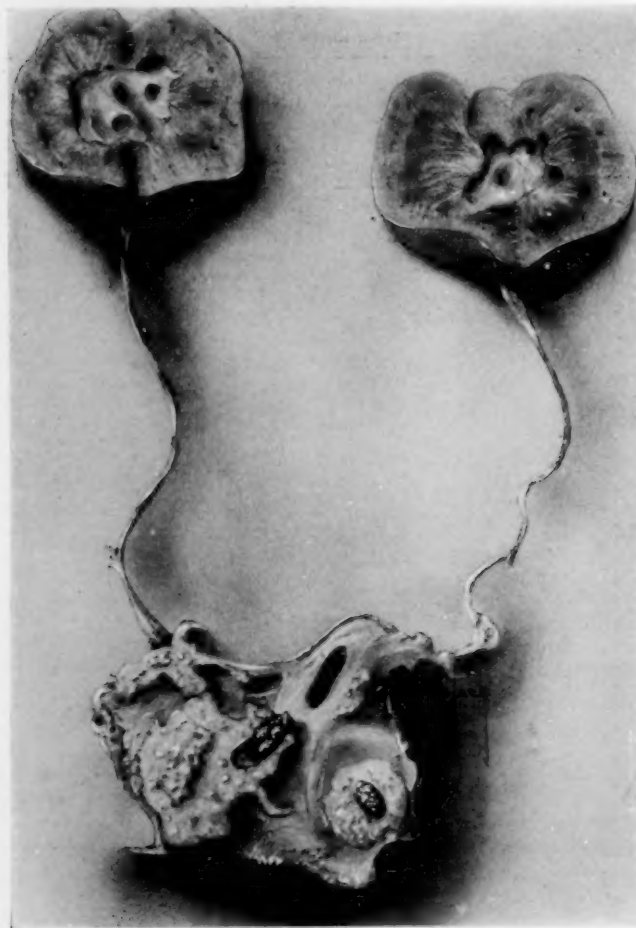


FIG. 6.—Experiment 132. Calcium oxalate stones in bladder. Result of intense oxaluria produced by injection of normal butyl oxalate and calcium chlorid.

oxalate crystals are present. The tendency of the spheroidal forms to undergo fusion or agglutination into larger masses is easily seen. The relatively few octahedral crystals, on the other hand, are seen to be isolated. It was also noted that the sand and calculi found in the urinary tract at necropsy were made up of these spheroidal units. (Fig. 8.)

FORMATION OF URINARY CALCULI

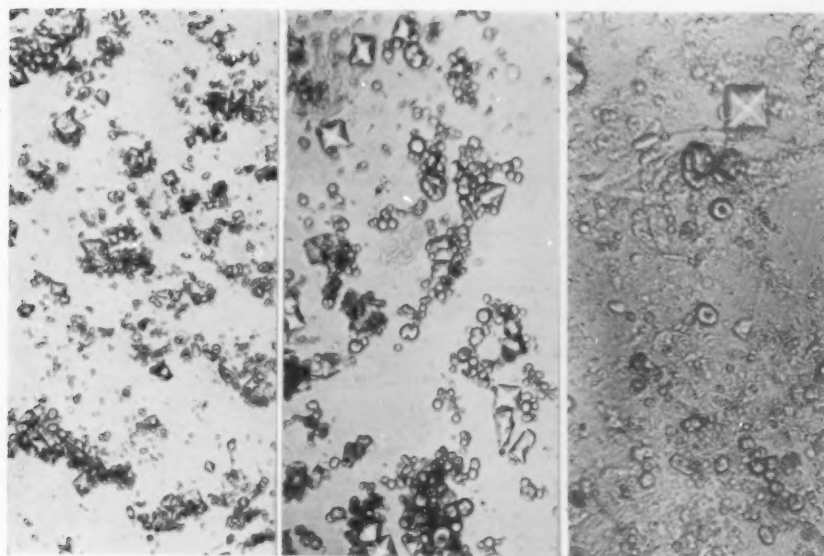


FIG. 7.—Sediments from fresh urine of rabbits with experimental oxalate lithiasis. An intense oxaluria. Discrete isolated perfect octahedra of calcium oxalate are seen, but the preponderant types are tabloids and coalescent dumb-bells and spheroids which are fusing to form concrements.

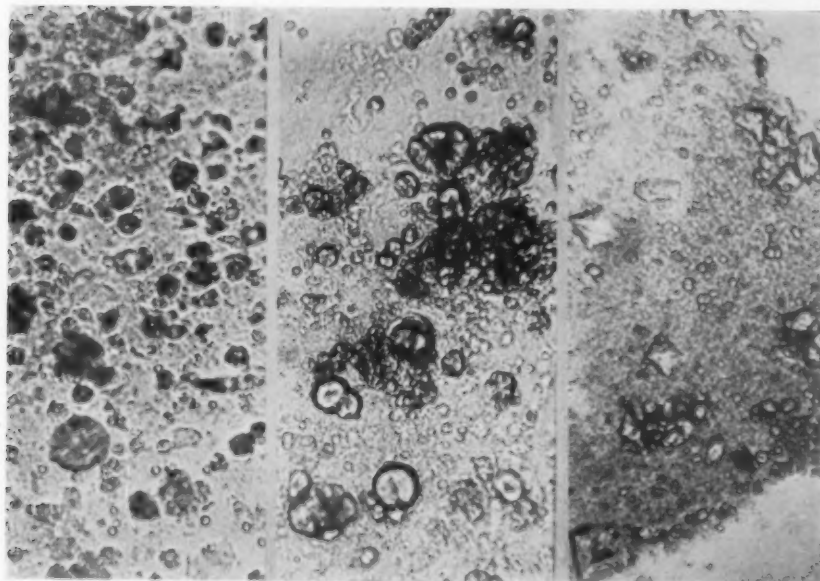


FIG. 8.—Small calcium oxalate calculi experimentally produced as in text, crushed on slides to show crystalline elements in structures. Note that the small fusing spheroids constitute the structural units.

The fusing spheroidal variety of calcium oxalate corresponded morphologically with the coalescent variety described by Ord. When this phenomenon was first noted in the urine of the experimental animals we immediately became hopeful that calculus formation might take place if the process were continued long enough. The results outlined show that our expectations were fully realized.

The kidneys of rabbits with oxalate lithiasis produced in this manner were uniformly swollen and pale. On cross-section the markings of medulla and cortex were partly obscured. Microscopic sections of such kidneys revealed varying degrees of epithelial destruction. Dotting the field in the region of the so-called secreting tubules were found masses of calcium oxalate deposited as rosettes, spheroids, and occasionally as octahedrons. These deposits lay free in the lumen of the tubules. No instances of oxalate deposition within the glomerulus or its capsule or in the proximal convoluted tubules were noted. No intracellular deposits could be determined.† (Fig. 9.)

Thus it was demonstrated that the experimental production of an excessive excretion of calcium oxalate in the urine over a prolonged period of time would result in the aseptic formation of calcium oxalate calculi. Furthermore, it was shown that the mechanism of such calculous production was related to a change in the morphology of the stone-forming crystals from a non-fusing to a fusing or coalescent type.

The physico-chemical influence of colloidal matter on crystalline morphology may theoretically, at least, be applied. We may assume that, by enormously increasing the quantity of the crystalloidal calcium oxalate in the urine, we overwhelmed the protective colloids of the urine which were present only in amounts sufficient to maintain the solution or crystalline isolation of the quantity of calcium oxalate normally present. When the quantity of oxalate excreted passed the limit of that capable of being handled by the urinary colloidal machinery, then fusion of crystals and calculus formation took place.

POSSIBILITY OF LITHIASIS FROM A DEFICIENCY OF URINARY PROTECTIVE COLLOIDS

The second phase of our experimental problem, namely, to produce a deficiency in the quantity or quality of protective colloid in the urine of animals, has thus far been baffling. Theoretically such a deficiency would render the urine incapable of maintaining solution or isolated crystal deposition of the normal quantity of crystalloid excreted. Thus, again, change from non-coalescent to coalescent crystal forms would take place and stone formation ensue.

† This method of producing oxalate deposits in the renal parenchyma may possibly be applied indirectly in the study of the excretory function of the various renal elements. The constancy of the deposits within the tubules composing the loops of Henle, their absence from the glomeruli, and their relatively slight quantity in the straight collecting tubules, are noteworthy in this connection.

FORMATION OF URINARY CALCULI

In our hands no positive results in this direction can be reported. However, Lichtwitz has demonstrated that the removal of colloidal matter from

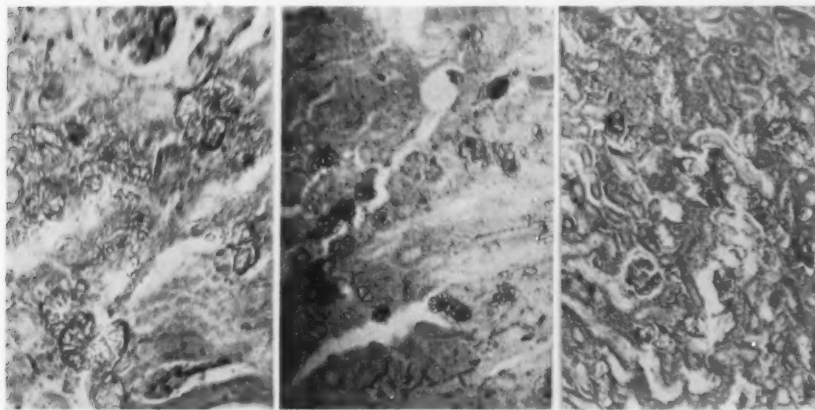


FIG. 9.—Oxalate deposits in renal tubules. A consistent finding in experimental calcium oxalate lithiasis.

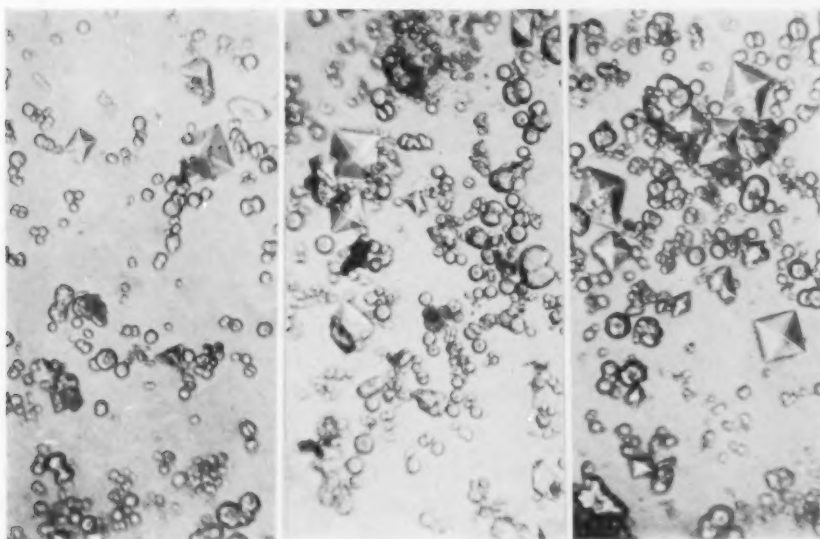


FIG. 10.—Sediment from freshly voided urine of patient A 334473. This patient has been passing calcium oxalate calculi frequently for years. Note similarity of the oxaluria to that experimentally produced. The predominance of coalescent forms is a remarkable feature.

urine *in vitro*, either by extraction with ether or benzene, or by dialysis, uniformly results in a precipitation of phosphates or of calcium oxalate. Furthermore, Schädé of Kiel, in 1909, produced stony masses *in vitro* by clotting fibrinogen in the presence of freshly precipitated phosphates, oxalates, and carbonates, thus giving tremendous impetus to the significance of colloidal factors in stone formation.

EXPERIMENTAL LITHIASIS FROM BACTERIAL EXUDATES

Studies tending to show that bacterial exudates may cause an interference with the normal urinary colloids in a manner to bring about an atypical precipitation of the urinary crystals and consequent stone formation have been even more fruitful. Last year it was noted that sodium oxalate fed to rabbits would produce a moderate degree of oxaluria of the octahedron type. By direct infection of the kidneys under such conditions with attenuated colon bacilli, the type of oxalate crystal was found to change to the spheroidal coalescent variety. Fusion of these crystals was noted with the formation of minute concretions in several instances. These experiments have been published in detail elsewhere. Again, Rosenow and Meisser, working with streptococci from the urine of patients with multiple recurrent calculi, have repeatedly produced calculi in the kidneys of dogs by the methods of specific bacteriology. These streptococci were implanted in devitalized teeth of dogs which developed urinary calculi consistently after an interval of several months.

Such experiments can best be explained by assuming that the bacteria have a specific elective activity on the renal tubules, thus producing a low-grade inflammation. The exudate from this inflammatory reaction pours out abnormal colloidal matter into the urinary stream. This we may assume so interferes with the normal colloidal balance of the urine that its solvent power no longer obtains, that deposition of fusing crystals takes place and stone formation occurs.

A single clinical observation in a series which we are now studying seems worthy of mention at this time. Case A334473, Mr. E. H., aged thirty-eight years, was admitted to the Mayo Clinic January 1, 1922. He had been passing sand, gravel, and a number of calculi for four years. Chemical examination of the stones showed them to be composed of calcium oxalate. The microscopic examination of freshly voided urine revealed intense oxaluria with the coalescent or spheroidal type of calcium oxalate crystal predominant (Fig. 10). In fact, the sediment from the urine could not be distinguished from that of the rabbits with experimental oxalate lithiasis. The urine gave a positive culture for streptococci. Eradication of foci and renal lavage was carried out. The patient had syphilis and returned to the Clinic six months later for treatment of this condition. A ureteral stone on the left side, noted at the first examination, was no longer present in the röntgenograms. Pyuria persisted, but no crystalline sediment was found in freshly voided urine. The patient had had but one attack of left ureteral colic since January. Here again is noted an association of atypical fusing crystals in the urine and calculus formation.

FORMATION OF URINARY CALCULI

CONCLUSIONS

In conclusion a schematic outline is presented of the possible mechanisms of stone formation in the urinary tract. Not every detail can be considered as final, but believe that the outline is consistent and correlates the clinical and experimental data satisfactorily (Table II).

TABLE II
Possible Mechanisms of Stone Formation

<i>Normal</i>	<p>Normal quantity crystalloid excreted plus Normal quantity and quality of urinary colloid yields Solution of crystalloid or deposit of crystals in isolated noncoalescent units</p>
<i>A</i>	<p><i>Excessive Quantity Crystalloid Excreted</i> plus Normal quantity and quality of urinary colloid yields Deposit of <i>Fusing Atypical Nonisolated Crystalline Units</i> and Stone Formation</p>
<i>B</i>	<p>Normal quantity crystalloid excreted plus <i>Deficient Protective Activity of Normal Urinary Colloids:</i> 1. Due to deficient quantitative or qualitative excretion of urinary colloid 2. Due to <i>precipitation of the normal urinary colloid or masking of its protective activity by foreign colloids in exudates of specific Bacterial infection</i>, by foreign colloids excreted as the result of <i>abnormal Metabolism</i> or produced locally by the action of some <i>toxic Metabolite</i> yields Deposit of <i>Fusing Atypical Nonisolated Crystalline Units</i> and Stone Formation</p>
<i>C</i>	<p><i>Excessive Quantity Crystalloid Excreted</i> plus <i>Deficient Protective Activity of Normal Urinary Colloids (as under B)</i> yields <i>Excessive Deposit of Fusing Nonisolated Crystalline Units</i> and Stone Formation</p>

It is to be noted that for a *given quantity of crystalloid* the amount of *active protective colloid* present in each case is *insufficient* to maintain solution or *crystalline isolation*.

The need for further study, especially from the biochemic and bacteriologic aspects, must be emphasized. The fact that focal infection, on the one hand, and an excessive excretion of urinary crystalloid on the other, may produce lithiasis, has been demonstrated at least from the experimental standpoint. By clinical application of this knowledge in the study of patients, we may hope to achieve much in prophylactic therapy.

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SKIN GRAFTING BY EXACT PATTERN

A REPORT OF COSMETIC RESULTS OBTAINED WITHOUT THE
EMPLOYMENT OF SUTURES

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THE covering of a skin defect by epithelial grafts leads to an early and complete epithelization and so to the minimum cicatrization and scar. This is, of course, of the highest importance from the cosmetic standpoint, and particularly about the face, eyelids, lips, and ears. Moszkowicz¹ and Esser² seem to have first described the valuable method of applying Olier-Thiersch grafts cut on molds which are buried in tissues. J. S. Davis applies the term "buried grafting" to this method. Esser makes a mold of sterile dental impression wax of the cavity which he desires to line and throws Thiersch grafts or pedicle flaps over this mold. Then he reapplies it and draws the edges of the graft to the skin edges which have been slightly undermined or else draws the skin edges together over the mold. This he found to be useful especially for lining gum,

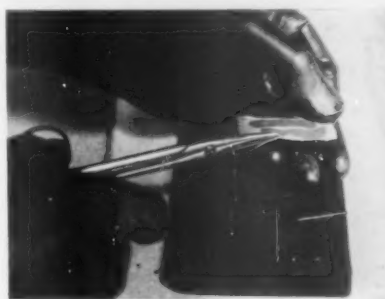


FIG. 1.—Method of trimming Thiersch-type graft to exact rubber-tissue pattern.



FIG. 2.—Application of patterned graft to wound of ear. Removal of pattern.

lip or ear defects, but also used it to cover the space from which Thiersch grafts were cut. Weiser³ modified this method for shallow surface wounds by fixing the mold on the cheek by a through-and-through nail with a flat adjustable screw head like a cuff link. Parce⁴ working with Keller has reported a series of several wounds of a more superficial nature on which the Esser method was employed. The skin edges were undermined in each case, and throughout this work Parce used rows of sutures to hold the grafts in place.

Our purpose has been to develop a method for exactly covering superficial wounds with epithelium without the necessity of undermining the edges and without the employment of sutures. The outlines of our wounds have, as a rule, except for their color contrast, been indistinct. Therefore rubber tissue seemed more desirable than wax for patterning their contour.

The method of using rubber tissue for patterning wounds in order to determine their exact area was recently published by the author in this journal.⁵

This and similar material has been employed for so many purposes in surgery that the writer claims no novelty in the present one. In view, however, of the good cosmetic results obtained in several recent cases, it has seemed expedient to describe in accurate detail the technic employed throughout.



FIG. 3.—After care: Lifting edge of graft to allow serum to escape. Spraying lightly with paraffine to prevent excessive drying.

On November 27, 1921, the Rialto Theatre fire flooded the New Haven Hospital with patients having first, second and third degree burns. As no patient escaped burns of the face, including the ear, the problem after the first few weeks became a cosmetic one. The writer reports the technic employed on the ears as best illustrating the value of the method. The problem here was how to provide hairless and color-matched skin over the entire burned areas on the ears; incidentally, in the more severe cases, to prevent the deformity incident to contraction of scar tissues.

In one of the cases a cartilage transplant was necessary to restore the contour of the ear. In the others, this was not done. Antiseptic solutions were

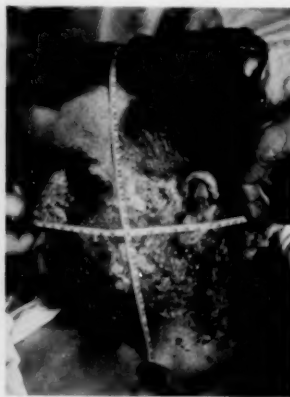


FIG. 4.—Burn of ear before grafting. FIG. 5.—Burn of ear before grafting. FIG. 6.—Burn of ear before grafting.

employed until the ears presented clean superficial granulating wounds of varying extents and outlines. The method used was as follows:

A. Patterns are made of the exact outline of the wound; either cutting out the rubber tissue directly with scissors, or tracing it with ordinary fountain pen ink and then cutting out. This is done either at operation or the day before, as is more convenient.

B. The right and left sides and the anterior and posterior surfaces of the patterns are labeled so as to avoid error.

SKIN GRAFTING BY PATTERN

C. After the usual iodine technic to the skin, the grafts are cut by the Thiersch method, using the regular Thiersch knife or a safety razor blade set in clamps. Since it is desired to have the skin hairless and very thin and soft,



FIG. 7.—Method of fastening pattern grafts to auricular surface.



FIG. 8.—Method of fastening pattern grafts to auricular surface.

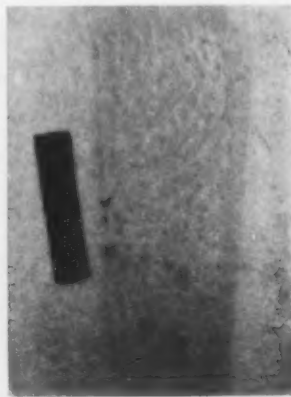


FIG. 9.—Wound left by removal of skin for ear. Six months post-operative.

the grafts are cut from the upper and external aspect of the thigh, below the belt line. If grafts of hairless skin could not be obtained, it would be advisable to "depilate" the grafts later by X-ray application. In determining the size of the grafts which will be necessary, one should keep in mind that



FIG. 10.—Final result on patients shown in figures 6 and 7.



FIG. 11.—Final result on patient shown in figure 8.



FIG. 12.—Final result on patient shown in figure 4.

the skin will shrink to about two-thirds or one-half of its previous size. Therefore the skin should be cut somewhat larger than the size that will cover the pattern. If, after cutting, the graft seems too thick, the excess fat may be removed by trimming its under surface with curved scissors. The pattern, with its posterior surface up and its right and left sides reversed, is then placed on a board and the graft spread out over it with the epithelial surface down. With the scissors, the edges of the already contracted skin are then

trimmed accurately to the edges of the pattern (Fig. 1). The excess skin may be put back on the wound or used for "pinch" grafts in other locations.

D. Next, the wound is cleansed with ether and the graft applied to it. After approximating the edges of the graft to the edges of the wound (Fig. 2), the rubber tissue may be peeled off. The graft is then fastened to the ear, the skin of which has been thoroughly cleansed with ether, by means of plain adhesive strips about 4 mm. wide (Figs. 7 and 8). Each strip is made taut



FIG. 13.—Final result on patient shown in figure 5.



FIG. 14.—Final result on patient shown in figure 5.



FIG. 15.—Keloid on burn of ear which was not grafted. Four months post-operative.

and is placed about 5 mm. from the next one. A pasteboard box held by tapes is then applied over the ear. After twelve hours, serum which will be found to have collected under the graft may be carefully removed by lifting up the edges with sharp sterile scissors which are wiped with alcohol between each puncture. The graft, still held by adhesive, which has been made more taut wherever necessary, is then sprayed lightly with a very thin layer of "Ambrine" or other paraffine preparation (Fig. 3.) The box dressing is reapplied. Usually in about six days it will be found possible to remove the adhesive strips without interfering with the grafts. The color of the grafts through the light coating of wax may be taken as an indication for the time of removing the adhesive. This may be done as soon as the grafts are definitely pink.

The summary of the cases treated in this manner is as follows:

Eight patients entered the hospital on the same day, November 27th, and all had first and second degree burns of the ears. (Figures 4, 5 and 6 show the burns of the ears of three patients before grafting.) The same type of grafts could therefore be applied to all. Of these, one was a female and the other seven males. Practically all were in a station of life where cosmetic results were highly desirable. In four, one ear was grafted; in the other four, grafts were applied to both ears. Five had previous skin grafts by other methods which proved unsuccessful. In six cases using this method, success was com-

SKIN GRAFTING BY PATTERN

plete; in the other two the grafts on one ear took well. On the opposite ear, in each case slight secondary infection temporarily caused a failure of a small portion of the graft with subsequent delayed healing.

In all cases, as the epithelial edge grew over the slight linear defect, the line of demarcation between the graft and surrounding skin became almost imperceptible. The color assumed by the grafted skin was very nearly that of the surrounding skin of the ear. All of the cases have been observed for a period greater than four months and results are satisfactory to the patients from a cosmetic standpoint. No hair has grown in the skin, which was chosen from a hairless site.

Figures 9, 10, 11, 12, 13, 14 and 15 are self-explanatory.

CONCLUSION

A method is described for the making of exactly patterned Thiersch grafts. Such grafts can be applied without suture or other mechanical methods of fixation and heal with the minimum of scarring.

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TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting Held October 25, 1922

The President, DR. JOHN A. HARTWELL, in the Chair

TRANSPLANTATION OF TOE

DR. HAROLD NEUHOF presented a girl seven years of age who was admitted to the Surgical Service of Doctor Lilienthal, Mt. Sinai Hospital, July 11, 1922, with congenital deformities of the hands presumably due to amniotic bands. On the left hand there was fusion of the third, fourth and fifth finger stumps and deformity of the left thumb and index finger. On the right hand the index finger lacked the distal phalanx and the middle finger was completely lacking. The other fingers were intact.

The first operation was a plastic procedure on the soft parts of the left index finger and thumb, with some resulting improvement in appearance. The second plastic procedure was for the separation of the fused stumps of the third, fourth and fifth fingers. For the defect of the middle finger of the right hand, a transplantation of the second toe with the adjacent tissues of the ball of the left foot, was planned. The first stage of the transplantation was carried out August 21, a plaster casing for the child being made a few days before. At the operation, the skin over the stump of the finger was reflected as a flap to the ulnar side, exposing the end of the bone directly adjacent to the metacarpal joint and the termination of the flexor and extensor tendons of the finger. The end of the bone was freshened and curetted, a wet pack was put in place, and the isolation of the second toe proceeded with. An incision was made across the web between the first and second toes, the incision being carried well up on the dorsum of the foot and down along its plantar surface. This incision made it possible to expose the second metatarsal bone with the flexor and extensor tendons of the second toe with the minimal dissection. The tissues over the lateral aspect of the second toe were left undisturbed, thus assuring an adequate blood supply. The second metatarsal was divided about 2 cm. from the head of the bone and the extensor and flexure tendons divided at this level. It was of course essential to transplant more than the toe itself in order to supply the desired length for the replacement of the missing finger. As a result of some further dissection the second toe with the adjacent metatarsal tissues hung on a pedicle consisting of the tissues on the lateral aspect. The greatest difficulty was in approximating foot and hand without tension. This was accomplished by drawing the left knee

TRANSPLANTATION OF TOE

well up, rotating the left leg externally at the hip and elevating the shoulders, particularly the right. Sutures of silk were now passed between the extensor and flexure tendons of the missing finger and the distal ends of the corresponding divided tendons of the toe. A suture of chromic gut was passed through the bone stump of the finger and the distal end of the divided metatarsal bone. After the hand and foot were fixed in the position in which adequate approximation of the tissues was possible, these sutures were tied. The flap of skin that had been reflected from the stump of the missing finger was sutured to the skin where it had been incised for the separation of the toe. The remainder of the skin incision on the foot was packed.

The post-operative course was trying for the patient and opiates were required to keep the child quiet in the necessarily uncomfortable position. She became accustomed to the position, however, after a few days. The sutures were removed on the sixth day. It was found that some separation of the skin had occurred owing to shifting of position and adhesive plaster was applied to maintain apposition. The toe remained warm and its circulation was good. Fifteen days after the first stage, the second stage was carried out. This consisted in making an incision along the lateral aspect of the second toe, in order to detach it. The space in which the dissection could be carried out was cramped, so that some injury to the tendons was probably inflicted. After the separation of the toe, together with the adjacent metatarsal bone and tissues, was carried out, it was evident that too much tissue existed in the ball of the foot for a satisfactory cosmetic result in the hand. It was therefore necessary to sacrifice not only the distal end of the metatarsal bone, but also much of the fat pad on its plantar surface. After this trimming of the tissues had been done the skin along the lateral aspect of the base of the toe could be sutured to the skin edge that was raised along the radial aspect of the stump of the finger. A few fine silk sutures were employed for this purpose. A splint was applied to the hand and the wound of the foot was strapped to obliterate the gap left by the loss of the second toe. After the patient recovered from the anaesthesia, the dressings were removed from the operative field of the hand, a thin layer of gauze put in place, and dry warmth with the aid of an electric light was employed. The process of repair appeared good, skin union and apparently union of the soft parts occurring. The circulation in the transplanted toe remained good from the outset. Sensation has begun to return, being now present to some extent over a considerable area of the skin of the transplant. X-rays show that the bones and joints of the transplant are as yet apparently normal. Slight motion is present in the transplanted toe but it has not as yet been determined that the tendons are intact. An operation for their repair may be indicated in the future. The cosmetic result is a great improvement over the previous appearance, but it is as yet too soon to state what the final outcome will be.

NEW YORK SURGICAL SOCIETY

PYOARTHROSIS OF THE KNEE

DR. HAROLD NEUHOF presented a woman, forty-two years old, who was admitted in March, 1920, to the medical service of Mt. Sinai Hospital with a history of cough and fever for four weeks, and a purulent discharge from the right ear for three weeks. Pain and swelling of right knee were first noted about two weeks before admission. Upon admission to the hospital there were the physical signs of an unresolved pneumonia in the right lung. The knee-joint presented a marked effusion with increased local heat. The appearance was suggestive of a gonorrhoeal arthritis, and a vaginal smear that was made showed gonococci. The patient was under observation for several days, during which period of time the joint lesion progressed. A white blood count and differential were normal. Slight fever was present. He aspirated the joint and found pus containing streptococci in spreads and operation was proceeded with. At operation there was found a large collection of pus in the knee-joint and the suprapatellar pouch. There were as well extensive pockets of pus and necrotic tissue behind and below the knee-joint, mesial to the heads of the gastrocnemii, and two similar pockets mesially situated to the hamstrings. These foci were laid wide open, and found to communicate with the posterior aspect of the knee-joint. Numerous Carrel tubes were introduced in the various pockets and to, but not within, the knee-joint for the administration of Dakin's solution. For about a week it was necessary to give anaesthesia to do the dressings. Carrel-Dakin treatment was then discontinued and gentle passive motions were begun. Active motions could only be instituted some two weeks later and then with the greatest difficulty. The wounds healed without complication but the improvement in the range of motion was very slow. The patient left the hospital with almost complete fixation of the joint and failed to go to the department of physical therapy for after-treatment. Upon examination at the follow-up clinic, the patient complained of generalized joint pains. A greatly enlarged spleen and liver of unknown etiology were found. The patient has a useful knee for ordinary purposes, with good power in the limited range of motion. Extension is complete, flexion is limited to about 90 degrees.

DOCTOR NEUHOF presented also a boy, fourteen years old, who was admitted to the surgical service of Mt. Sinai Hospital February 13, 1922. Ten days before admission coryza and fever had been present for forty-eight hours. Pain in the left knee set in two days later. This became progressively more severe. The joint became swollen and tender. High fever up to 104° , began three days before admission, and persisted. On admission the patient looked acutely ill, with a dry tongue, and in agonizing pain. The only positive finding other than the knee-joint was an acutely inflamed pharynx. The knee-joint was tense with fluid, exquisitely sensitive, the overlying skin hot to the touch. The suprapatellar pouch was distended and the surrounding

PYOARTHROSIS OF KNEE

soft parts were infiltrated. Blood culture was negative. At operation the joint was first aspirated, pus containing streptococci in spreads that were made being found. Free lateral joint incisions were made, from the top of the suprapatellar pouch to the bottom of the knee-joint, traversing the quadriceps musculature. The joint contained pus under tension, and the suprapatellar pouch presented a perforation in its uppermost portion where the pus had begun to extend into the muscular planes. No drains were inserted. A temporary splint was applied. From the outset active motion was tried. Even with liberal administration of morphine it was soon found that this could not be carried out by the patient. Resort was therefore had to passive motions, which were gently carried out, within the limits of pain, every two hours. The temperature dropped to normal by lysis in one week. For three weeks no really active movements could be instituted. Then, with the aid of a Bier bandage applied around the mid-thigh, they could be begun by the patient. The support of the body weight and efforts at walking were not possible until six weeks after operation. Rapid improvement in the range of motion and power then set in. Normal function is now present in the joint, with full range and power. There remains some atrophy of the thigh musculature.

DOCTOR NEUHOF presented also a boy, ten years of age, who was admitted to the surgical service of Doctor Lilienthal, Mt. Sinai Hospital, on January 25, 1922, with a week's history of pain in and swelling of the left thigh, high fever, delirium. He presented a profoundly septic appearance with great enlargement and tenderness of the left lower thigh. The left knee-joint was held slightly flexed, motions were limited, and there were evidences of an effusion into the joint. A blood culture taken before operation was later reported positive, six colonies of staphylococcus aureus to the cubic centimetre. At operation, directly after admission to the hospital, the knee-joint was aspirated. Cloudy fluid was obtained containing very few cocci in spreads. It was therefore decided to deal with the bone lesion alone. A subperiosteal abscess entirely surrounding the femur in its lower half was incised. Massive necrosis of this portion of the femur and multiple pus foci were encountered when the bone was laid open. Carrel-Dakin treatment was instituted from the outset. The general condition of the patient remained poor for five or six days after operation, although the temperature dropped towards normal and the progress of the wound was satisfactory. The point of significance here is the fact that the moderate effusion in and limited motion of the knee-joint persisted. Ten days after operation the temperature began to rise. Although there was no evident change in the condition of the knee-joint other than apparently increasing sensitiveness over the inner aspect, it was thought advisable to explore the joint. Upon aspiration of the joint only a small quantity of pus was obtained and it was therefore believed that the suppuration had spread to the periarticular bursæ and an incision was made over the

posterior aspect of the joint laterally to the vastus internus. Pus under tension was encountered here, and the tract was found to communicate with a wide opening into the joint. The articular surface of the femur in this region was denuded and roughened and was apparently the source of infection. The posterolateral bursæ were not explored and this proved to be an error as the subsequent course showed. The temperature ranged at a lower level, but the patient's general condition did not improve. Active motions of the joint could not be carried out, but limited passive motion was possible. Finally, some fulness in the popliteal region appeared and an incision was made to expose the posterolateral bursæ one week after the previous operation. Two small pockets of pus and necrotic material were encountered in the region of the bursæ. These communicated freely with the posterior aspect of the joint from which pus escaped. After this operation, active motions of the joint could be carried out by the patient despite the extensive wound in the femur, and convalescence was rapid. In this case it is noteworthy that the usual incisions laterally to the patella proved unnecessary in the treatment of the knee-joint infection. There now remains a large sequestrum of the femur extending almost to the knee-joint, which will require operation. The thickened bone that surrounds it interferes with full flexion of the knee, the bony impact being felt upon flexion to 100 degrees. Full extension is present.

DR. JOHN A. HARTWELL said it would be interesting to know if any other member of the Society has had experience with the Willems' treatment and, if so, if the results have been as satisfactory as they have been in Doctor Neuhof's cases. The Willems' treatment was intended for traumatic arthrosis, which is different from the septic conditions of private life where infection is through the blood stream. It was the speaker's opinion that these latter patients will not make the needed effort at coöperation and that they are unable to put into effect the walking treatment.

DR. ALLEN C. WHIPPLE noted that Doctor Neuhof had brought out one point, and that was the difficulty in getting these patients to use active motion. The speaker had had several of these cases in the last year and a half, and this was one of his greatest problems in carrying out this form of treatment. The intelligent patient will coöperate and carry out active motion; if there are no secondary pockets and if there is no osteomyelitis, the results are astonishing. But in his four or five cases, in children, particularly in two where both extremities were involved, the carrying out of active motion was out of the question.

DR. ROYAL WHITMAN said that in cases of the type shown, active movement as a means of drainage was impracticable because the tissues outside the joint, even the muscles themselves, were involved in the disease, and voluntary motion was therefore inhibited by pain.

DR. HUGH AUCHINCLOSS thought the crux of the whole thing was the early stage in which treatment could be started. He had in mind one patient who had a small focus in the inner condyle of the femur demonstrable

DIVERTICULITIS OF STOMACH

in four or five days. The boy, nine or ten years of age, was very sick. He had a suppurative knee-joint. There was a small bone focus in the shaft near the epiphyseal line which was drained. He had six positive hæmolytic staphylococcus aureus blood cultures, and six aspirations of greenish-white pus from the joint with 1 per cent. carbolic washings into the joint after each aspiration. With the exception that he had a certain amount of varus deformity, he has regained complete function in the knee-joint which was never drained. If localized infections in the bone or soft parts about the joint are adequately drained early, before necrosis of the joint lining has taken place, joint drainage may be quite unnecessary and aspiration suffice.

DR. EDWIN BEER believed that after this presentation of the good results of the mobilization treatment of suppurative conditions of the knee, it would be well to give some attention to the poor results. One can never tell in advance how a suppurative knee-joint is going to behave. Similar cases treated along parallel lines have behaved surprisingly differently. The speaker had had to do an osteotomy to straighten out deformity following the use of the Willems' method. It was certainly an improvement over the old drainage operations, although cases did not regularly give as satisfactory results as had been shown this evening.

DOCTOR NEUHOF, in closing the discussion, said that his experience with the Willems' method of treatment was limited to some eight or ten cases, and the patients selected for this evening's presentation were chosen because they did not all represent ideal results. All the cases he had seen, however, had useful limbs with some degree of motion, and he had not experienced the extremely unsatisfactory results to which Doctor Beer referred. The point he wished to emphasize was that he had not usually found it possible to carry out the Willems' treatment, as far as active motion was concerned, in civil practice. He believed that the method of free incisions and omission of drainage tubes, etc., was a great advance in the treatment of knee-joint infections. But in his experience active movements after operation cannot usually be made by the patient. In contrast to healthy soldiers with knee-joint lesions, these are patients who have a systemic infection of which the affection of the knee-joint is but one manifestation and who are usually debilitated by the disease. In connection with Doctor Whitman's statement that active extension of the knee-joint is impossible, the speaker said that those who have seen wounded soldiers with knee-joint infection treated by the Willems' method have seen that they do have active extension at the knee. Satisfactory results, however, could be obtained by passive movements.

DIVERTICULITIS OF STOMACH

DR. JOHN F. CONNORS presented a woman, twenty-five years old, who was admitted to the hospital on August 16, 1922, with a diagnosis of appendicitis. Chief complaint, distress after meals. Family history, negative. Previous history, indigestion for the past five years, otherwise irrelevant. Present history: Day before admission patient began to

feel sick, complaining of headaches, nausea and cramp-like pains throughout the abdomen. Upon questioning the following history was elicited: Immediately after a few mouthfuls of food there is a fulness in the left upper quadrant of the abdomen. Patient says she is able to relieve this by massage and moving about. Lately she has been taking her meals standing. With this distress there are frequently gaseous eructations and sour tastes, but there is no vomiting. This distress is always in the same area, *i.e.*, in the left upper quadrant of the abdomen, in which constant tenderness is present. She does not suffer from hunger pain. Of late she has discontinued using sour liquids and starchy foods, because of the great distress which follows. Vegetables and cereals are her principal diet. Physical examination shows a vague tenderness over the entire abdomen. There is no marked tenderness or rigidity. Blood count on admission was: Leucocytes, 16,000; polymorphonuclears, 81 per cent.; lymphocytes, 19 per cent.; erythrocytes, 4,250,000; hæmoglobin, 80 per cent. The urine was negative. Wassermann was negative. As it was felt that she did not have an appendix, a G. I. X-ray series was ordered, which revealed the following:

Six-hour examination reveals a retention in a pouch-like formation of the greater curvature, pars cardia, just opposite the epicardial portion of the œsophagus. There is no other gastric retention.

As two more tablespoonfuls of the barium mixture are given, this does not fill the pars pylorica as usual but fills the pouch first; as more of the opaque mixture is given the last overflows the pouch and passes into the pars pylorica. The pouch formation which appears like a diverticulum is persistent on three different examinations. The last examination having been done after administration of tincture belladonna (as antispasmodic) for five days 15 drops t.i.d.

Similar cases have been described occasionally in English and foreign literature under the name of "cascade stomach," which this pouch may resemble. In cases of "cascade stomach" there is marked distention of the splenic flexure of the colon, which presses constantly on the pars cardia, the constant pressure forms an artificial diverticulum and later due to irritation, adhesions may be formed between this pouch and surrounding serous membranes.

At operation, for a vertical distance from 1 to 2 inches opposite the spleen and the corresponding gastric border the connecting omentum was apparently absent, leaving an opening. This opening was bounded above by a distinct and strong band (1 inch by $\frac{1}{4}$ inch), extending from the cardia to the spleen and containing blood-vessels of a size to give rise to active bleeding until secured by double ligatures, and separated by a slight interval from the upward continuation of the gastro-splenic omentum and the remains of the dorsal mesogastrium, which was thin and apparently bloodless.

Below, this opening was bounded by a firm, sharp margin which was continuous, inferiorly and to the right, with the remainder of the

ARTERIOVENOUS ANEURISM

gastro-splenic omentum and gastro-colic omentum. Near this sharp margin ran a blood-vessel of good size which resembled, and followed the course of, the gastro-epiploica sinistra.

This opening led into the lesser peritoneal sac, as was demonstrated when a finger introduced through an artificial opening in the gastro-colic omentum could be touched by another through the above-mentioned opening.

Through this space the greater curvature (slightly) and a varying amount of posterior gastric wall, depending upon the amount of gastric contents to push it forwards, would protrude and overhang the sharp lower margin.

There were no adhesions, induration or other evidences of inflammation. The stomach walls were quite normal, save for apparent slightly thinner wall in the region of the herniated portion, as from repeated stretching.

ARTERIOVENOUS ANEURISM

DR. JOHN F. CONNORS presented a young woman, twenty-five years of age, who on July 4, 1922, sustained several severe cuts on the right forearm, following the breaking of a wind-shield. These were sutured by a physician. On July 28th, three weeks after the injury, patient noticed a small localized swelling on the right forearm at the site of the previous injury. This swelling has gradually become larger and more painful. Physical examination is negative except for the local condition. There is an expansile, pulsating swelling just below the bend of the elbow on the radial side of the forearm. At present it is the size of a marble. The characteristic bruit can be heard and was transmitted upward to a more marked degree than below. The radial pulse could be felt at the wrist, but there was a decided difference between the right and left sides. There was no apparent swelling of the forearm. For the past two weeks she says the pain has been increasing.

Operation.—An incision was made to the inner side of the swelling and with the exception of a few adhesions the aneurism was easily exposed and dissected free. There were no branches leading into the sac which was entirely venous, and no distention of the coats of the artery. A catgut ligature was placed above and below the sac on the vein. A ligature was placed around the artery above the aneurism. This ligature was not tied, but by pulling it angulated the artery and controlled the bleeding. The sac in the vein was then bisected, making two uneven flaps. An opening in the artery about 1 cm. in diameter was found. The ligature was loosened and the bleeding became active. The ligature was then drawn taught and the repair of the artery was made by a transverse suture of chromic catgut. The coats of the vein were placed over the suture line and this was reinforced by a piece of fascia and the wound closed in layers. There was improvement in the radial pulse but there is still some difference, and I do not feel that

there is as much improvement as I expected from my experience with other cases of similar character. The patient is free from pain and has perfect function of her arm.

He was led to operate upon this case by the history of the increase in size of the swelling. He had deviated from the orthodox method of smearing the tissues with petroleum as advocated by the early workers in this field which was intended to impede coagulation by the dropping of a one per cent. solution of sodium citrate into the field of operation.

SUPPURATIVE PERICARDITIS

DR. EDWARD WADSWORTH PETERSON presented a child, aged three and one-half years, who was admitted to the service of Doctor Dennett, at the Post-graduate Hospital on June 14, 1922, with a history of being ill for two weeks before admission, with loss of appetite, occasional vomiting, green stools, and constant elevation of temperature, fever as high as 104. The mother claims that the illness began just after the child was struck on the head with a stone, although there was no evidence of any trauma whatever. There was much complaint of frontal headache. On the ninth day of her illness she had a convulsion, lasting 20 minutes. She had been coughing for two days before coming to the hospital.

June 15, 1922: Physical examination showed nothing out of the ordinary except "few crackling râles and bronchial breathing heard just outside and below nipple." Diagnosis, broncho-pneumonia.

June 23, 1922: "Heart sounds are very distant, rate about 140, regular. Heart area enlarged to right of sternum, and dullness extends on left to anterior axillary line in third and fourth interspaces. Thick mucous râles heard over both lungs anteriorly and posteriorly. Dullness and diminished breath sounds at right base, probably due to enlarged liver. Liver palpable three fingers below right costal border."

X-ray examination showed a rather large pericardial effusion. The child, while acutely ill, had not been in a critical condition until June 20th, when the temperature rose to 104, respiration 40 to 60, and pulse 160. The breathing became labored. There was cyanosis of the lips. On June 23, Doctor Sanctis introduced a needle and withdrew thick pus from the pericardium. On the following morning, with the child in a sitting posture, on account of dyspnoea, under local anaesthesia, the left sixth costal cartilage was resected, the internal mammary artery ligated and the pericardium exposed, without opening the pleura. The pericardium was seized with fine clamps and opened. Thick pus, under pressure, escaped. With a suction apparatus such as is used in throat operations the remaining pus was aspirated. The pericardium was sutured to the chest wall. *No drains were used.* Following evacuation of the pus there was marked improvement in the patient's general condition. In order to secure good drainage, the child was made to lie face downward, for a period of thirty minutes, every two or three hours. The little patient coöperated nicely in this respect and they were able to secure gravity drainage of the pericardium from the start. The

SOLITARY CYST OF LIVER

wound healed completely in about one month and at the present time the child seems perfectly normal with regard to cardiac function.

Just before her discharge from the hospital (July 20) the following was made: Ventricular rate 132. 1. Auriculo-ventricular tachycardia. 2. "T" is flat in leads I and III and negative in lead II.

This is not a typical record of congenital heart disease. If there is clinical hypertrophy neither ventricle is preponderating. The significance of the changes in the "T" deflections is not proven.

It is interesting to note the prompt and apparently perfect recovery in this case of suppurative pericarditis. Only time will tell whether there will be any trouble, due to adhesions. The postural treatment, without any drainage material in the pericardium, seems to be a step in the direction of avoiding the usual complications.

SOLITARY CYST OF LIVER

DR. EDWARD W. PETERSON presented a woman, thirty-two years of age, who on March 25, 1922, at 11.30 P.M., was awakened by an attack of severe pain in right upper quadrant of abdomen, pain radiating to left breast. There was no nausea, vomiting, chills or fever, with the initial seizure, nor at any time during the six weeks before he saw the patient. From the time of the attack the patient was never free from pain and got but little sleep, and as she was unable to lie down, she had to secure her rest sitting up. There was much belching of gas when the pain was at its height. The appetite and digestion were poor. Bowels were constipated. Urination was negative. Sixteen pounds loss of weight.

When the patient was first seen by him on May 8th, she was apparently suffering considerable discomfort, walked with the body well to the right. Upon examining the abdomen there was rigidity and tenderness over the whole right side, but it was most marked over the gall-bladder area. No palpable masses could be felt, but the examination was unsatisfactory owing to the right-sided rigidity.

On May 9th, the abdomen was opened through a high right rectus incision. Gall-bladder apparently normal, but pushed upward and outward, by the distention of the under surface of the liver. The right lobe of the liver was enlarged, tense and fluctuating. An aspirating needle was introduced and first a straw-colored and then brownish, hemorrhagic fluid withdrawn. The needle opening was enlarged and a large cavity, holding approximately 600 to 800 c.c. of fluid, was entered. Owing to the free bleeding it did not seem wise to attempt to remove the cyst lining. A large tube was placed in the opening on the upper surface of the liver, and a large double tube was introduced below, just external to the cystic duct, and brought out behind, between the tenth and eleventh ribs, giving through-and-through drainage. The appendix was removed. Following operation there was profuse drainage for the first few days. The patient's temperature ranged from 100° to 105° and did not reach normal until the tenth day. For the first week the

patient was seriously ill, then there was gradual improvement in all symptoms. On the seventh day the anterior drainage was removed. After that the cyst cavity was irrigated daily with Dakin's solution.

An attempt was made about two weeks after the operation to remove the posterior tube, hoping that by this time a sinus would take care of the drainage. Patient felt chilly that night, had pain, cough, and general malaise. As soon as a smaller tube was introduced the unpleasant symptoms disappeared. Patient was discharged from hospital on June 4, 1922. It was not until July 12th that the tube was removed, although it had gradually been shortened, just in order to prevent healing of the external wound. It was late in July before the drainage stopped and the sinus healed.

The cyst fluid which was sent to the laboratory showed fibrin, red cells, and a moderate number of leucocytes and round cells. No parasites or ova were found.

Non-parasitic cysts of the liver are rare and, in 1916, Moschcowitz found only 83 cases in the medical literature. The solitary non-parasitic cyst is found only in women. Bland-Sutton suggests that such a cyst is formed from the dilatation of the bile ducts, which fuse and form the cyst. Simple drainage will usually effect a cure.

DETAILS IN THE SUSPENSION AND TRACTION TREATMENT OF FRACTURES

DR. JAMES N. WORCESTER read a paper (with lantern illustrations) with the above title.

To illustrate the paper, he presented a young woman, who on October 20, 1921, slipped and fell, landing on her outstretched left arm. She was put up with Velpeau bandage. X-rays taken showed fracture of the surgical neck of the left humerus with angulation. She was taken to Reconstruction Hospital, October 25th, and was placed in a suspension frame with traction of 10 pounds. It was impossible at first to abduct the arm more than 15 degrees, but with the traction, at the end of three days, the arm was brought out to a position of marked abduction and rotation by increasing the degrees of these positions gradually.

X-rays, November 1, 1921, show almost perfect position at site of fracture. Kept in suspension frame for twenty-nine days. After removal of this the passive motion of the shoulder joint was practically normal in range and the active motion showed only slight limitation of abduction. Returned to work as stenographer day after discharge from the hospital. With exercise and massage complete normal rotation has been regained so that it is impossible now to tell which arm was fractured. This case was shown simply to demonstrate that when this method of treatment is used the long period of disability following the union of the fracture is done away with and the total length of disability very much decreased.

SUSPENSION AND TRACTION OF FRACTURES

DR. ROYAL WHITMAN limited his comments to the treatment of fracture of the neck of the femur by traction. Possibly the reader did not fully appreciate the fact that the problem of treatment of fractures at the hip was quite different from that of fractures elsewhere. For, since the neck of the femur projected laterally, traction, however efficient in other situations, could at best appose the fragments only in a lateral and therefore insecure relation. It was admitted that what were classed as good results, according to the present standard, might be attained by this or any other method, if the fracture were incomplete or at the base of the neck. The true test was the so-called intracapsular fracture. In this type the fragments were of small area, and as there was no external callus formation, direct repair required a security of exact apposition similar to that for bone grafting.

This could be assured only by the abduction method, in which the fragments brought into a horizontal plane, and therefore end to end, were forced into contact in complete abduction by the tension of the enclosing capsule, a position in which muscular contraction, so difficult to control by external splinting or by traction, could have no influence whatever as an agent of deformity.

Traction by the weight and pulley, however effective in reducing shortening, was a most unreliable means of maintaining apposition. This point was illustrated by several of the lantern slides of fracture of the shafts, in which the fragments were actually separated by excess of tension. This separation, of no consequence where there was such potentiality for repair, would, he believed, preclude union in fracture of the small part of the neck because the fragments rapidly disintegrated unless contact were assured.

He thought there could be no question of the technical superiority of the abduction method as a means of restoring and maintaining the primary essentials of functional repair in all types of fracture at the hip. Furthermore, it had the great practical advantage that it was under single control, in the sense that once properly applied success was not dependent as was any traction method on an intelligent coöperation that could not be assured under ordinary conditions. Finally the treatment had a far wider range of applicability to aged and infirm patients than any method that required dorsal recumbency, since it permitted elevation of the head of the bed and frequent changes from the dorsal to the ventral position, thus preventing hypostatic congestion and bed-sores.

In experienced hands the abduction treatment had become a commonplace routine, including cases formerly thought to be ineligible for any treatment—with a far lower death-rate than from life-saving neglect, and with results that compared favorably with those of other fractures in patients of the same class.

The most constant criticism was that voiced by the reader that "the plaster treatment" was often uncomfortable and unsatisfactory. He would emphasize the point that the abduction treatment was not a plaster treatment.

NEW YORK SURGICAL SOCIETY

It was an anatomical method in which the plaster spica served the subsidiary purpose of holding the limb in the attitude that made the internal splinting effective. The plaster spica was the only support at general command, and when properly applied it served its purpose admirably. He concluded that the skill and assiduity required to make an inadequate method effective even in a hospital ward would make the abduction treatment practicable on a comprehensive scale under the conditions to which, in the great majority of cases, the treatment must be adapted.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held November 6, 1922

The President, DR. JOHN H. JOPSON, in the Chair

CHRONIC EMPYEMA

DR. NORMAN S. ROTHSCHILD presented a woman, aged twenty-four years, who was admitted to the Medico-Chirurgical Hospital, service of Dr. John H. Jopson, January 21, 1922, with the following history:

Had lobar pneumonia three and one-half years ago. Three days after onset, she began to have pleuritic pain. Two days later pus was aspirated from the chest and a rib resection was performed. Drainage tube was pulled out by the patient the next day. Several months later, there was marked purulent discharge from the wound, which has continued up to the present time. A year and a half before admission chest was reopened and it has been draining since that time. When admitted the lung expansion was limited on the left side. Tactile fremitus is greatly diminished on the entire left side. Percussion note is flat—more marked posteriorly. Breath sounds are distant throughout the posterior surface of the left chest and laterally below the level of the fifth rib. No râles heard. There is a sinus at the level of the sixth and seventh ribs posteriorly in the post-axillary line, which is discharging greenish pus, which on examination contained a Gram-positive diplococcus and diphtheroid bacilli.

X-ray examination revealed the entire lower half of the left chest to be of a density sufficient to consolidation, due largely to the pleural thickening, with some exudate. Injection of the sinus reveals a cavity approximately 7 cm. in depth and about 3 cm. in width.

Operation on February 1, 1922, consisted of a resection of the seventh and eighth ribs on the left side. At this time the exploration of the cavity revealed it to extend to the clavicle above and to the eighth rib below. About one quart of pus was evacuated. Dakin tubes were introduced at the time of operation, 75 c.c. of Dakin's solution being injected every two hours during the day and every four hours at night following operation. Six days after Dakinization, twenty-nine organisms per oil immersion field were found. Eight days after Dakinization, twenty-four organisms per oil immersion field were found. Culture of the Dakinized cavity revealed staphylococcus aureus and few diphtheroid bacilli. Seventeen days after operation, nineteen organisms per field were found. A gradual reduction was obtained and on the fifty-ninth day only two per field were observed. Fifty-eight days after operation patient developed a severe dermatitis and Dakinization had to be stopped. Sixty-three days after operation Dakinization was resumed

as dermatitis had somewhat subsided. Capacity of the cavity was ninety cubic centimetres. Smear count was four to a field. Culture from the depth of the wound was negative. Sixty-eight days after operation three organisms per field were found. During this period patient's general health was improving. Temperature was subnormal in the mornings and normal in the afternoons.

On April 25th, eighty-four days after this operation, patient had a hemorrhage into the pleural cavity, which was evidenced by blood-soaked dressings. This was apparently controlled by horse serum. On May 17th, 106 days after the operation, the first stage of the Keller operation was performed under nitrous oxide and ether anæsthesia. A U-shaped incision was made extending from the fourth rib parallel to and behind vertebral border of the scapula, curving down to the eighth rib and then anteriorly to the sixth rib in the anterior axillary line. The fourth, fifth and sixth ribs were resected. (The seventh and eighth had been resected at our first operation.) Muscles attached to the vertebral border of the scapula were severed near their vertebral attachments and were folded and sutured under the skin. The roof of the cavity was completely exposed. Parietal pleura was removed. The cavity was packed and the upper and lower margins of the wound were sutured. Three days later the packing was removed under nitrous oxide anæsthesia. Dakin tubes were inserted. Dakinization was again resumed. Blood count at this time was 3,150,000 red blood cells, 9400 white blood cells, 50 per cent. hæmoglobin. Differential counts showed 50 per cent. polymorphonuclears, 35 per cent. small lymphocytes, 3 per cent. large lymphocytes, 2 per cent. transitionals and 1 per cent. eosinophils.

On June 20th, thirty-four days after the first stage of the Keller operation, smears showed an occasional bacillus and culture showed bacillus pyocyaneus. On June 28th, forty-two days after the first stage, the second stage operation was performed. An incision was made just outside the margin of the granulation tissue of the old wound. The granulation tissue was removed. The skin which had been folded over the muscles of the outer wall of the chest at the first operation was dissected up uncovering them. The visceral pleura was considerably thickened. The cavity was clean and free from pus. Part of the visceral pleura measuring about three by four inches was dissected from the lung. The remainder was incised in criss-cross incisions. The latissimus and other muscles were loosened from the under surface of the scapula and the resulting flap was sutured to the floor of the cavity. The arm was brought to the side and the edges of the wound at the upper and lower ends were approximated with silkworm-gut sutures. A large perforated sheet of rubber dam was placed into the wound and the opening was then packed with gauze, the whole being forced to the bottom of the wound.

Seven days after this operation the dressings were changed and there was considerable greenish, watery discharge from the wound. Eleven days after this operation Dakin tubes were inserted and Dakinization of the wound was begun. From this time the discharge decreased in

FRACTURE-DISLOCATION OF LUMBAR VERTEBRÆ

amount. On August 2nd, thirty-five days after this operation, tubes were removed. On August 6th patient was discharged from the hospital with very little drainage. Subsequent examination of the patient revealed that the wound is completely closed and that the movement of her left arm, which following the second operation was considerably impaired, is now returning to normal, although she cannot completely elevate the arm. Her general condition is excellent, and there is surprisingly little deformity of the chest visible, following this extensive resection of its wall. She is stout and the considerable amount of subcutaneous adipose tissue conceals to a certain extent the chest collapse. The result leaves little to be desired. It will be noted that in this case the major part of the wound was left open after the second stage operation and muscle implantation. Colonel Keller, operating step by step, according to indications and the patient's resistance, completes his technic by secondary skin suture, the ideal method. In this case such suture was not done and the wound healed by granulation. At the time of this operation we had not had access to the published reports of Keller's work, giving the full details of his admirable technic.

FRACTURE-DISLOCATION OF LUMBAR VERTEBRÆ

DR. JOHN B. WOLFE presented a man, thirty years of age, born in Austria, immigrated in 1907; father living and well, age sixty, mother died at thirty-six following childbirth; one brother and three sisters living and well. Patient denies previous disease or injury, is married; five children are living and well, the oldest is ten years of age, the youngest born April 11, 1921. Occupation always that of a laborer. He was a moderate user of beer and wine. He was injured March 18, 1921, while loading a car of coal in the mines by a fall of rock, which struck his back, hurled him to the ground, jamming his head forcibly against the mine car with resultant deep laceration of the scalp in the left frontal region; marked shock, undoubtedly augmented by exposure to cold during the two hours required to extricate him, and motor paralysis, which was total and complete from the waist down. He was transported to the hospital, lacerated scalp was sutured and healed without further complications. Primary treatment was directed to shock, which was extreme for forty-eight hours, which seriously threatened the life of the patient and which precluded all thought of surgical interference. An air mattress was employed and every precaution taken to prevent bed-sores—fortunately none developed.

At the end of the first week there was continued total and persistent motor paralysis with loss of reflexes; sensation was impaired but sphincter control maintained. There was a large hæmatoma overlying the site of injury. A rather unsatisfactory X-ray (taken with portable outfit) showed so much vertebral fracturing that any pressure or manipulation was deemed dangerous. Accordingly a Buck's extension was applied to both legs, as much as thirty pounds being used at times with counter-extension to the head. Extension was maintained for eight weeks in the hope of attaining the maximum of reduction, and after the second week improvement in motor function was apparent almost from

PHILADELPHIA ACADEMY OF SURGERY

day to day; the right leg and thigh responding first, the left more slowly, the peroneal muscle group in each leg being the last to become normal. Passive movements, electricity and massage were instituted after three weeks and a splint used from the outset which maintained the foot at a right angle and prevented stretching of tendons or contractures of muscle groups.

Röntgenological examination on June 3, 1921, showing a crushing fracture of the third and fourth lumbar vertebræ with displacement of fully one-half the width of the vertebra of the caudal end to the right and with anterior displacement of the third lumbar vertebra upon the fourth the depth of the vertebral body. There are also fractures of the lateral processes of the third, fourth and fifth vertebræ, with extensive callus formation especially upon the left side. (Fig. 1.)

Patient was fitted with a brace and began walking on July 1, 1921, and on the 15th walked from the hospital with the aid of a cane. On October 1st there was recovery of power in both legs with, however, a tendency to fatigue, he had practically dispensed with the brace and walked well, being able to do more than a mile before becoming exhausted. During November, he returned to work as "gate-tender" in the breaker and has worked steadily since. At the time of writing (September 26, 1922) color and musculature are good; gait and posture are normal and there is no evidence of paralysis—he swung himself onto a table three feet high for X-ray examination with less apparent effort than the average. There is rather marked lumbar kypho-scoliosis and the site of fracture can be palpated as a bony prominence. He works daily, walking to and from a point one mile from his home and is not especially fatigued at nightfall. Height 5 feet 6 inches; weight 136 pounds; height before injury 5 feet 8 inches; weight 160 pounds. There is fixation of the third, fourth and fifth lumbar vertebræ, otherwise forward, backward and lateral body movements are normal. The knee jerks are still absent. Comparison of X-ray films made September 25, 1922, with those of June, 1921, show marked increase in callus formation, especially in the lateral aspect. The patient's mental attitude is excellent and he notes continued improvement in his condition.

VOLKMANN'S CONTRACTURE

DR. JOHN H. JOPSON presented a girl, age nine years, who was brought to the Presbyterian Hospital on September 22, 1922, with a fracture near the elbow-joint. The house surgeon diagnosed it correctly as supra-condyloid, and after an attempted reduction was about to dress it in the Jones' position when he noted that the radial pulse was absent at the wrist in the injured arm. With excellent judgment he admitted her to the ward and applied a Thomas splint, dressing the arm in the straight position with light extension to the forearm and hand. The examination the following day showed moderate swelling of the elbow, the radial pulse still absent, but the circulation in the hand and fingers was good. X-rays showed a supra-condyloid fracture about 1 cm. above the epiphysis, the upper fragment presenting a sharp spine

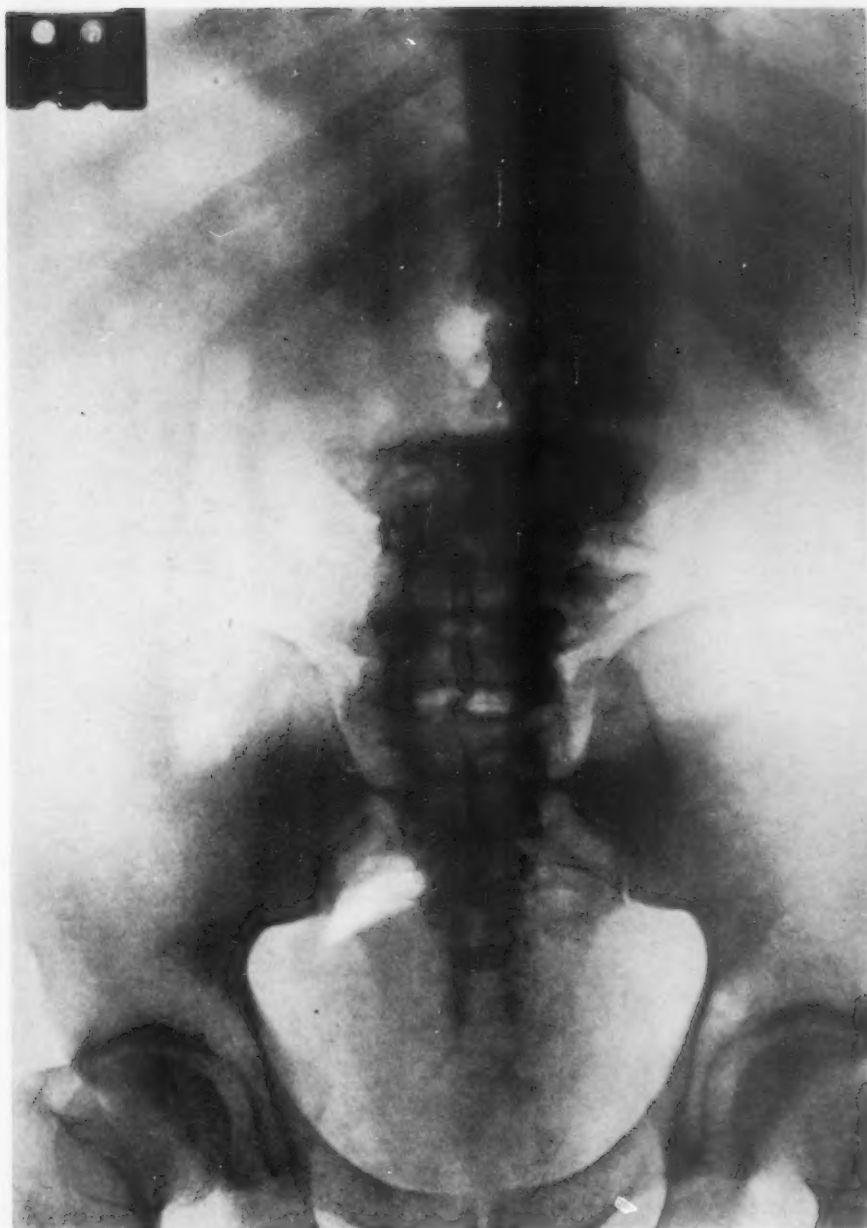


FIG. 1.—Fracture—dislocation of lumbar vertebra.



VOLKMANN'S CONTRACTURE

forward, the lower fragment of the joint displaced upward and backward and toward the outer side. Extension was removed and the arm allowed to remain dressed in the suspended Thomas splint. On the second day, circulation still being good in the hand, reduction was attempted under nitrous oxide anaesthesia and the arm dressed on an anterior angular splint. Subsequent X-rays showed no improvement in position. Six days after the accident, the swelling having subsided, open reduction was practiced through an external incision. After reduction the fragments were fixed by one silver wire suture and the arm dressed in flexion in a modified Jones' position. Subsequent X-rays show good correction. About a week after operation it was noted that the wrist and fingers were assuming the characteristic contraction of an ischaemic paralysis. Evidences of nerve injury were lacking, and this was confirmed after careful examination by Dr. Williams Cadwalader, the hospital neurologist. A splint was applied to the hand and forearm, and daily massage was ordered. It is now six weeks since the injury. Union in the fractured bone is complete. There remains some contraction of the flexor muscles of the hand and wrist, which is improving under treatment. The elbow movements are still very limited. There is a firm induration of the muscles on the anterior surface of the forearm and the elbow, which is most pronounced in the flexor and pronator groups in the upper part of the forearm and in the brachialis anticus. The hand and fingers are still supported by a Jones' cock-up splint, and this is removed daily for treatment. The diagnosis is Volkmann's ischaemic paralysis, due to primary brachial artery thrombosis, the result of the injury, and not from the usual cause, namely, tight bandaging. The case is a mild one and the prognosis is favorable for complete recovery.

A very excellent article on this subject by John Jacques Thomas appeared in the *ANNALS OF SURGERY*, March, 1901. Theories advanced up to that time included among its causes arterial obstruction, interference with the return venous circulation, compression, and nerve injury. The last mentioned is regarded by Thomas among others as secondary and contributing, but not a necessary factor. It was present in over one-half of the cases. Tight bandaging is not always a factor. Gibbon has reported one case due to treatment of a fractured elbow in the Jones position. Scudder emphasizes the usual origin of this complication of elbow-joint and forearm fractures as being too great pressure upon the soft parts, causing the characteristic ischaemic myositis. He also admits some cases are due to vessel thrombosis where no splint has been used, and quotes Littlewood to the same effect, the latter including simple extreme swelling of the soft parts and prolonged exposure to severe cold among the exciting factors. As Scudder puts it, "the contracture is the result of prolonged interference with the normal circulation." This is the only case we have seen which was not due to the improper use of splints. It is very clearly due to arterial obstruction, with or without interference, at the same time and from the same cause, with the return venous circulation. The arterial obstruction resulted from the fracture, and not from the after treatment.

PHILADELPHIA ACADEMY OF SURGERY

STABILIZATION OF WRIST JOINT BY BONE GRAFT IN SPASTIC PARALYSIS

DR. WILLIAM JACKSON MERRILL exhibited a case of spastic hæmi-plegia involving chiefly the upper left extremity. It is due to a birth injury. The symptoms appeared when the patient first began to use the left arm. The function of this arm has been practically nil and he has carried it in the characteristic position with continuous spasm, increased on any attempt at function. He was subjected to operation January 20, 1920. A graft about two and three-quarters inches in length by about one-quarter to one-half inch in its other dimension was taken from the crest of the tibia to be inserted into the lower end of the radius and into the carpal bones as follows: Incision was made through the skin and subcutaneous tissues in the line of the third metacarpal bone and the mid line of the radius. With a twin saw a groove was cut in the radius and into the carpal bones to receive the graft. The graft was placed in the groove and held in position by a kangaroo tendon. The wrist was dressed in a 45 degree cock-up position and held firmly in that position by a plaster case from the tips of the fingers to the shoulder. The flexor tendons of all of the fingers were completely stretched before the splint was applied. This position was maintained by case for about a year. Substituting the case aluminum metal splints were used for a period of over a year. Subsequently a palmar cock-up splint was worn.

These removable splints were used especially for the purpose of beginning function as well as massage and manipulation. When the arm was carried in its characteristic contracted position the spasm of the flexor muscles of the wrist and fingers seemed to increase the general spasticity of the entire upper extremity, even the deltoid was markedly spastic and the pectorals so markedly contracted that the arm could not be abducted beyond 45 degrees. When the case was removed, the spasticity in the flexor muscles of the fingers was very greatly reduced and the spasticity of the other muscles of the upper extremity was markedly lessened.

Soon after the removal of the splints, after continued massage, manipulation and exercise, the patient began to use the fingers; abduction of the thumb was only about 30 per cent. normal and the extension of the fingers about 80 per cent. of normal.

This range of motion, however, enabled patient to grip objects, tie his tie, lace shoes, hold fork, button coat, and so forth. The stimulus of function seemed to add a great deal to voluntary control also to benefit physically. The improvement continued until function has reached its present range. He now can do practically 70 per cent. of acts in his normal regime, play certain games, even golf, using a left-handed club because of the diminished range of motion of the upper right extremity.

Doctor Merrill said that he had tried arthrodesis on the wrist to stabilize it in the cock-up position but without any great success but with a decided improvement. It occurred to him that if the wrist could be placed in such a position that the extensor muscles of the fingers would have an advantage over the flexor muscles, that they could extend the

HÆMOLYTIC JAUNDICE

fingers and permit of function and it seems better to gain that function in this manner than to do so by weakening the flexor muscles, thereby diminishing their function. Furthermore, without stabilization of the wrist it was possible again for flexion contracture to take place, which condition seemed to increase the general spasticity. He had also seen marked improvement in spastic contracted wrists and hands after wearing a cock-up splint for several weeks. Naturally when the splint was removed the contracture deformity recurred. The X-ray shows the graft in place and that osteogenesis has been quite active, and the picture indicates that arthrodesis of the wrist and bone graft are capable of holding the hand in its present cock-up position. The wound healed by first intention, the progress of convalescence was unimpaired and the improvement was even more than anticipated.

HÆMOLYTIC JAUNDICE—TREATED BY BLOOD TRANSFUSIONS

DOCTORS GEORGE M. LAWS AND WILLIAM BATES reported the case of a man, age thirty-six, who, after a series of digestive disturbance extending back some two years, developed severe pleurisy-like pain on the left side. One week later jaundice and weakness began which have steadily progressed, and recently he had had two severe attacks of pain under the right costal margin. Has had an increasing pallor for the past three or four weeks.

The man was a well developed adult who showed some apparent loss of weight, a deep general jaundice, marked scleral jaundice, slight tenderness below each costal margin, and a moderate enlargement of the spleen. Otherwise his physical examination was entirely negative.

On January 31, 1922, he was admitted to the American Hospital for Diseases of the Stomach for observation and treatment. His clinical findings showed a temperature varying from normal to 100° F., a pulse rate varying from 84 to 104, and a respiratory rate of 20. His first blood examination on day after admission showed red blood cells, 1,730,000; white blood cells, 11,200; hæmoglobin, 34 per cent.; a coagulation time of four and three-quarter minutes and a differential of polymorphonuclears 80 per cent., large mononuclears 7 per cent., small mononuclears 12 per cent., and eosinophils 1 per cent.; a negative blood Wassermann and a negative blood culture.

Urine was turbid, yellow, normal odor, specific gravity of 1.015; alkaline reaction; very minute trace of albumen, 0.003 per cent.; absence of glucose, diacetic acid or acetone; a slight excess of indican; a large excess of urosium, and no bile, microscopically there was one hyaline cast, a few squamous epithelial cells, and many shreds with enormous number of triple phosphates.

A gastric analysis—Ewald test meal—36 c.c. removed in one hour, was 50 per cent. solid residue, and was slightly blood tinged. There was a small amount of mucus, a total acidity of 54, a free HCl estimation of 24, and a strongly positive occult blood reaction.

Fæces were also positive for occult blood. X-ray studies were made which showed no pathology of the stomach or duodenum, and no gall-stones.

Dr. O. H. P. Pepper, in consultation, made a diagnosis of hæmolytic jaundice of the acquired or Hayem Widal type as compared with the familial type, and advised blood transfusion at five or six intervals, to be followed by splenectomy if patient's condition improved sufficiently to make the operation reasonably safe.

Eight transfusions were made, seven of them being by the citrate method and by each of these 500 c.c. was injected; the other one was done by the syringe method, and when 30 c.c. had been injected the patient went into shock.

Of the eight donors, all of which were tested by cross-agglutination with the patient's blood, five were direct blood relatives, either brothers or sisters. After none of these five did we have the slightest reaction, and a study of the urine after transfusion showed no erythrocytes, no hæmoglobin, and no bile, except once we had a few red blood cells reported.

Of the other three donors, some reaction followed each transfusion, one of them, previously mentioned, being a severe degree of shock. All three resulted in chills and subsequent rise of temperature. The urine after one of these showed many red blood cells, and after the one leading to shock it showed many red blood cells, considerable hæmoglobin, and some bile for the first time.

The direct result of each one of these transfusions on the cell count was difficult to determine, but at one time the patient was in much better condition than on admission, and the temperature was absolutely normal. At this stage after one more transfusion it was intended to do a splenectomy, but he never again reached a point where it was felt that it could be done with any degree of safety.

During his sojourn in the hospital he had several attacks simulating biliary colic. Repeated examinations of his spleen showed a progressive enlargement during the whole eight weeks. Following one of his transfusions he developed a thrombotic pile, which was exceedingly annoying but apparently not related in any way with his general condition.

On admission there was a complaint of cough which required constant medication, and about twenty-two hours before death he started with an uncontrollable cough which persisted until death.

DR. O. H. PERRY PEPPER said that these cases of hæmolytic anemia merge on the one hand into the familiar group of so-called pernicious anemia, which cases are often not acute or very severe; and on the other hand, into the extremely severe acute hæmolytic anemias which are usually rapidly fatal. It is in this latter group that one especially desires to remove the spleen, for these are the more actively hæmolytic cases. But unfortunately it is in these very cases that transfusion is most likely to be followed by a severe reaction. In other words, the cases which one most wishes to splenectomize are at the same time the cases in which one will have the greatest difficulty with transfusion reactions. The case reported will exemplify this. This case also illustrates the not infrequent occurrence that the early transfusions are followed by no reaction, but after repeated transfusions have been given reactions commence

EMPYEMA THORACIS

to appear. The blood of the patient reported showed a higher percentage of young cells than in any other case he had observed, and from this it may perhaps be assumed that the hæmolytic process in this patient was extremely active. This suspicion is borne out by the clinical course of the case.

DR. GEORGE M. DORRANCE said that he was accustomed to make the usual grouping test. He also tested blood against blood and believed this to be the proper method. He had had a similar experience where the question came up of using citrated blood or blood direct. He could not find any difference in this particular case. If anything the citrated blood gave less reaction. Lately he had been interested in seeing if it is true that citrated blood gives more reaction than whole blood. If the transfusion is not large he had not found any difference. In cases of a large amount of transfusion citrated blood gives more reaction. Sometimes he gave one transfusion of whole blood and a few days later a transfusion of citrated blood. He never had any tremendous reactions and he believed it to be largely due to the fact that he used old tubes, boiling them over and over again. New rubber tubes will give reactions constantly.

DR. D. L. DESPARD said that he had had a number of very violent reactions from using the citrated methods, very frequently œdema of the lungs, and in one case convulsions and death. For that reason he had not used the citrated blood method for five or six years. He never gave over five or six hundred c.c. by either of these methods. No reaction followed from the direct blood transfusion, and so had abandoned the citrated method.

DR. JOHN H. JOPSON remarked that Doctor Speese had been doing most of his transfusions by the citrate methods, in the Presbyterian Hospital, and he does not get these violent reactions.

DOCTOR LAWS said that this case report might have been entitled: Failure of blood transfusions to prepare a severe case of hæmolytic jaundice for splenectomy.

They were confronted with a patient who was exceedingly ill and they had very little in the literature to help them to gather information as to what was to be expected from transfusions.

EMPYEMA THORACIS—ANALYSIS OF TWO HUNDRED AND FIFTY CASES TREATED AT THE CHILDREN'S HOSPITAL OF PHILADELPHIA

DR. HENRY P. BROWN, JR., read a paper with the above title.

DR. A. P. C. ASHHURST said that it was his conviction, based largely on the studies of Dr. T. Turner Thomas, that drainage should be made at the most dependent point in the cavity. While he did not go as far as Doctor Thomas does in resecting the eleventh rib invariably, yet he does do so in some cases. Usually he selects the tenth or the ninth, and not in the posterior axillary line, but at a point much nearer the spinal column. The angle of the scapula normally comes down over the eighth rib in the posterior axillary line, and though one may draw the scapula up by elevating the arm during the operation, yet if one drains as high as the eighth rib, the scapula will come down to its normal

PHILADELPHIA ACADEMY OF SURGERY

site after the operation, and interfere with direct drainage. Moreover, even if the scapula were absent drainage at the level of the eighth rib is not low enough in the pleural cavity.

DR. EDWARD B. HODGE spoke of the various types of infection, for this, he believed, is an important point. The streptococcic cases do much better if aspirated several times, postponing formal drainage until they have recovered from their pneumonia, and until adhesions have had a chance to form, then either intercostal incisions or rib resection may be done, as indicated. The pneumococcic cases are not generally as ill and the adhesions form earlier, so that preliminary aspiration is not as important or necessary, and usually primary rib resection has been the procedure.

He made his incision posteriorly at the angle of the scapula and as low down as the aspirating needle reveals pus, always bearing in mind that the diaphragm comes up higher in children than in adults.

DR. T. TURNER THOMAS, referring to dependent drainage, recalled that years ago, the elder Doctor Ashhurst put in a sound, felt the tip of the sound below and cut down on it. A recent English writer thinks the best place for drainage opening is about the sixth or seventh rib because it is opposite the deepest part of the empyema cavity and therefore the last to be filled in by the expanding lung. Doctor Thomas thought, however, that the lung is driven away from the chest wall and its expansion denied by atmospheric pressure, and that the last portion of the lung to reach full expansion is that opposite the opening in the chest wall because the atmospheric pressure is most effective there. When the drainage opening is down at the bottom and atmospheric pressure acts best there, keeping the lung and the diaphragm away from the opening until it is ready to close.

DR. JOHN B. ROBERTS said that he long ago came to the conclusion that no statistics are worth while if obtained from several operators in a hospital unless they all use the same technic. It is waste of time for good men like Doctor Brown to look up old records; almost every operator lets the after-treatment go to someone else. This invalidates statistics. If one takes 100 cases of operations by one man and has him look after his own patients, the conclusions are worthy of belief. He did not think much of statistics obtained otherwise.

A very large number of empyema cases in adults and children need no serious operation; though the quality and variety of the bacteria make a difference in the disease. He thought that quick incision under local anæsthesia, without resection of the rib, drainage by a tube and good care afterward is the treatment. He uses daily irrigation when the temperature goes up a day or two after the operation. The tube should be gradually shortened and not left in for too long a period.

DR. JOHN H. JOPSON said that Doctor Brown had brought out and emphasized the choice between intercostal incision and rib resection; his statistics distinctly favor the latter operation. While this may seem a trifling difference it is not so. For years Doctor Jopson had followed the work of those of his

EMPYEMA THORACIS

colleagues who used an incision only, and he had been impressed by the number of cases requiring secondary operations. He remembered the time when Dr. John Ashhurst, Jr., made two incisions with through-and-through drainage, a different method entirely.

As to the use of Dakin's solution in children, his experience in young children has been that the method is poorly borne. He had found that after the use of Dakin's solution one finds that the child is just "not doing well;" there is a loss of physical strength and a deterioration, the cause of which is difficult to determine. He did not know whether this was due to the repeated irrigation or to some hypersusceptibility to the chlorine solution. Lilienthal mentions having made the same observation.

DR. D. L. DESPARD remarked in regard to the place of incision, one should bear in mind that the object is drainage, and that it should be theoretically at the most dependent point. Most surgeons lose sight of the fact that when the chest is open the diaphragm ascends. He had seen more than one case where the incision had opened up the pleural surfaces which while sealed did not contain pus. He does not think it makes any difference whether one resects or makes an intercostal incision. In the use of Dakin's solution, he had found it very difficult for a nurse with a number of other patients to take care of, to do the Dakinization properly, until a chart was devised which shows in graphic lines the number of bacteria per day, and which also has a space in which the nurse was required to put down the hour in which the irrigation was performed. Since the installation of these charts he had not had any trouble. This was a fairer way to test its use and they have gotten much better results by using it.

DR. J. S. RODMAN emphasized the importance of the bacterial study; the streptococcic cases do better under aspiration, at first, followed by adequate drainage. The pneumococcic cases recovered with almost any type of treatment. As to Dakin's solution, the use of this solution greatly improved the results both as to mortality and morbidity. It is highly important that it be used with the Carrel technic in order that it be brought into contact with all parts of the cavity. In fact in using Dakin's solution anywhere it is essential to remember the necessity of three things—time, concentration and contact. In other words, if a septic cavity is to be sterilized the solution in proper concentration must be brought into contact with all parts of the cavity, at regular intervals. No one who has taken the trouble to use Dakin's solution properly in these cases can fail to be impressed with its rapid bactericidal and solvent properties. With no other method had he seen these cases clear up so quickly, and cases sterilized with Dakin's solution presented almost normally expanding lungs instead of the rigid fixed ones so commonly seen when drainage alone is used.

CORRESPONDENCE

SPIRAL FRACTURES

EDITOR ANNALS OF SURGERY:

Sir:

I have but recently discovered a rather serious error in my paper on "Spiral Fractures," which appeared in the ANNALS OF SURGERY in October, 1921, and am writing to ask that in some number of the ANNALS, the following corrections be made and appear in the index: Page 492, line 8, the first word "right-handed" should be "left-handed" and in line 9, the word "left-handed" should be "right-handed"; line 19, the first of the words "left-handed" should be "right-handed" and in line 20, the word "right-handed" should be "left-handed."

I hasten to say that the error did not occur on your part, but on mine, in transcribing from one copy to another, it somehow escaped rather careful proof-reading.

I am asking that this correction be made as far as any such correction can be made, because of its importance. Although if anyone were to read the article critically, he would appreciate that the statements referred to above were clerical errors.

Very respectfully,

EMMET RIXFORD, M.D.,
San Francisco, Calif.

HYPERTHYROIDISM WITH ASSOCIATED DIABETES MELLITUS

EDITOR ANNALS OF SURGERY:

Sir:

The opportunity was recently afforded us of studying a patient suffering from hyperthyroidism with a complicating diabetes mellitus. Much has recently appeared in the literature tending to give the impression that this is not an unusual finding, but such has not been our experience. In the one hundred patients with hyperthyroidism immediately preceding this one no evidence of a true diabetes mellitus was found. The interest in our case lies in the association of two distinct clinical entities in the same individual, the comparative safety of early operative interference, and the effect of modern treatment on diabetes mellitus when a complicating hyperthyroidism is removed.

Report of Case.—History.—Case 13045. Mrs. H., aged fifty-five, came to the Clinic complaining of headache, painful swelling of the neck and frequent urination. Her family history showed her mother died of diabetes at forty-four. The patient had always been in robust health (except for nocturia for the last nine years) but since the summer of 1921 had suffered from chronic headache. Since December of that year, there had been a painful, progressive enlargement of the neck. Since January, 1922, she believed she was passing a larger amount of urine than normal and that her thirst and appetite were greatly increased. At

CORRESPONDENCE

the time of examination she was easily fatigued and sleep no longer rested her. June, 1921, she weighed 245 pounds, in March, 1922, 188.

The patient was a large fat woman, apparently fifty, of healthy appearance and showing no evidence of loss of weight. There was no exophthalmos, and the ocular muscles and fundi were normal. The tendon reflexes were uniformly exaggerated and there was a fine tremor of the extended fingers. Neck examination revealed a large, smooth, firm thyroid. The right lobe was very prominent, the isthmus easily palpated, and the left lobe flat and lobulated. The blood-pressure was 152, systolic; and 110, diastolic; pulse rate varied from 84 to 96, and the temperature was slightly elevated. Dermographia was marked and both palms and soles were hyperidrotic. Physical examination elsewhere was negative.

Laboratory Findings.—On admission to the hospital (March 27, 1922) a twenty-four-hour urine specimen revealed:

Amount	2010 m.
Specific gravity	1.042
Glucose	6.5 per cent.
Albumin	a trace
Casts	hyaline and granular
Acetone and diacetic acid++	

Blood examination:

Fasting blood-sugar	0.44 per cent.
Non-protein nitrogen	36.2 per cent.
Uric acid	2.65 mgs.
Urea nitrogen	14.00 mgs.
Chlorides525 per cent.
Hæmoglobin	90. per cent.
Red cells	4,800,000
White cells	9,200

Basal metabolic rate was +49.5.

Subsequent Course.—From March 27th to April 10th the patient was gradually de-sugarized by Joslin's method. She responded so well to this regimen that it was not necessary to reduce the diet below one thousand calories per diem. On April 13th the blood sugar was .19; the urine was sugar and acetone free, and the basal metabolism was +40. The next day the thyroid was removed under local anæsthesia and after an uneventful recovery the patient left the hospital May 2nd. Treatment was continued under Joslin's plan, but due to her apprehension over continued loss of weight (188 to 150 pounds), her diet was arranged to conform with Woodyat's formula in June. This modification gave her:

Carbohydrates	38.32 gms.
Protein	89.98 gms.
Fat	214.75 gms.
Calories	2,457

The patient has continued on this diet up to the present, is maintaining weight and is in excellent general condition.

DRS. WILLIAM COLE AND IRWIN C. SUTTON,
The Johnson-Wickett Clinic,
Anaheim, Calif.

CORRESPONDENCE

GASTRO-JEJUNOSTOMY FOR PERFORATED GASTRIC AND DUODENAL ULCERS

EDITOR ANNALS OF SURGERY:

Sir:

I wish to mention that personal (including some unpleasant), experience convinced me, years ago, that the operation for closure of the perforation does not, *per se*, cure the ulcer, and forced me to adopt the following routine:

(I) Seal the perforation *as quickly as possible*. Keep the patient in bed for one month on milk and mist-carbonatis *ter die*.

(II) Then perform, when feasible posterior, gastro-jejunostomy. Again keep the patient in bed on milk and mixture of bismuth, soda and magnesia for a further thirty days.

(III) Follow, for ensuing month, with a pap dietary, emphasizing the necessity for slow and deliberate mastication. Before leaving your charge present the patient with a menu of careful "gradual" feeding for the following year. Add as postscript never retain a carious tooth or pus bag in your jaw.

It is my firm belief that if, in cases of ulcer treated by gastro-enterostomy, one were to adhere to thirty days' rest of stomach and body, followed by intelligent feeding for one year and then switched on to a permanent plan of dietary, etc., as sketched in my essay "Gastro-enterostomy and Some Dietetic Rules," *British Medical Journal*, February 25, 1922, we should hear much more about the virtue of gastro-jejunostomy, and a great deal less about the necessity for gastrectomy, which, by the way, substitutes another sore which has to be dealt with by the natural factors of repair, and which, I find, sometimes passes into the condition of chronic ulceration ending up in cancer.

The fact must not be ignored that the human cells have got to do the healing, and given the general feeble power of repair which obviously must exist in every one who possesses a chronic ulcer of the stomach, is there any reason to assume that the chances excluding operative shock, etc., of cure are enhanced by the substitution of a huge acute wound for a small chronic one which at one time, originated in a small acute lesion?

These remarks apply to operations performed with the aid of a sharp knife in observance of the rudimentary natural law, the sharper the knife, the cleaner the cut and the more rapid the healing.

Recently some, who only see through diathermic spectacles and who evidently have not taken the moral to heart "He was well, he wanted to be better, he took medicine and he died," have been booming excision of *all* gastric ulcers by fire irons. I confess the mere thought of a deep "burnt" wound, with its physiological aftermath plus cancer potentiality in a stomach wall compels me to cling to an accustomed rule, in surgery exorcise the logic of the tinker.

CORRESPONDENCE

At one period I went in for excision of "everything," even some chronic ulcers of leg. This extension of surgery soon ceased, as I frequently found that, instead, I had obtained a chronic one of double the size.

Continuing this simile, I beg my readers carefully to compare the rational treatment for the cure of an ulcer of leg, *vis.*, absolute rest with limb elevated on a suitable back splint and soothing aseptic medication until the sore has healed with what one now reads of as all the rage for the cure of an ulcer of the stomach after gastric operation, early administration of solid food "to buck him up," early out of bed, "to keep his blood moving. Archaic to reflect as to what "the sappers" may think of peristalsis and food stuff, contempt in general for the term rest and everything possible vouchsafed to render the application of physiology, and the rationale, for the operation, short circuit, a perfect farce.

I do not wish it to be inferred that in cases of ulcer surrounded with enormous induration, *probably* beyond power of resolution—much less in cases in which there exists a *reasonable* suspicion of cancer—that I advocate gastro-enterostomy instead of gastrectomy, but I do maintain that when the latter is essential the former should be added plus an after-treatment which will correspond to the natural law of repair.

SIR JOHN O'CONOR, M.D.,
Buenos Aires, Argentina.

P. S.—Since the above was sent for publication I have learned, from *Ochsner's Surgery*, 1922, the source from whence sprang the idea that the operation for closure of a perforating gastric ulcer cured this lesion. I can only reiterate that I have treated cases in which the symptoms afterwards became as accentuated as before, and which posterior gastro-jejunostomy without loop, which, by the way, I have exclusively practised, without clamps and without a single instance of peptic ulcer intervening for twenty years, followed by common sense rest—cured the patients.

Recently I have known of a sad fatality in which the secondary treatment was neglected.

Until I had read above edition I was unaware of the proportion that charring (to 6th degree) of the stomach wall had assumed in certain quarters. I am unable to reconcile myself to the creed that such a practice is worthy of the term surgery or physiology—in my opinion it is a mockery of both in that it is opposed to the laws which favor the restitution of normal tissue—a factor which must be seriously contemplated when one operates on the debilitated stomach wall of a devitalized (gastric ulcer) subject.

I cannot but think that sooner or later this stunt will render its dividend of remorse to those who perpetrate an act on a hidden stomach wall which would be considered penal if performed for ulcer on an exposed surface of the human body.

If the patient's power of repair is capable of eliminating the eschar produced by such a burn, it affords proof that, given the ordinary surgical treat-

CORRESPONDENCE

ment above advocated, the ulcer would have healed, the induration would have disappeared and that gastrectomy by fire irons was an added insult to the natural process of cure.

As before mentioned, if, when the part is exposed, one conscientiously and after deliberate examination, concludes that cancer is probable, hesitation should cease and a free excision should be made of stomach well wide of the involved zone, and as anything is justifiable in cancer, said excision can be made by a cautery, or by any other method which will tend towards rapidity in execution and prevention of hemorrhage in a patient who is, alas, already "half dead."

But on an off chance to sizzle around the circumference of a mass, which if cancerous possesses cells which rapidly permeate by the lymphatics, in the hope that such circumscribed mutilation of everything will check the advance of cancerous cell migration is, in my humble opinion, an unworthy performance.

I tremble to think of the potential elements ultimately attending a "burnt" cicatrix in the mucous coat of a stomach which is unable to resist ulceration following a small infarct.

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